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BEAN CULTURE

GLENN C. SEVEY

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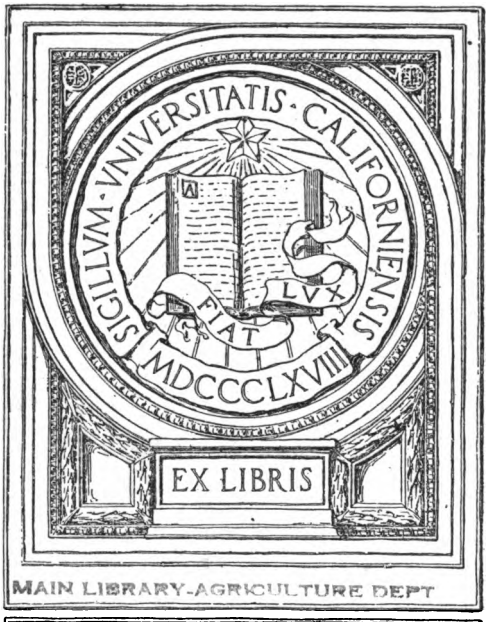

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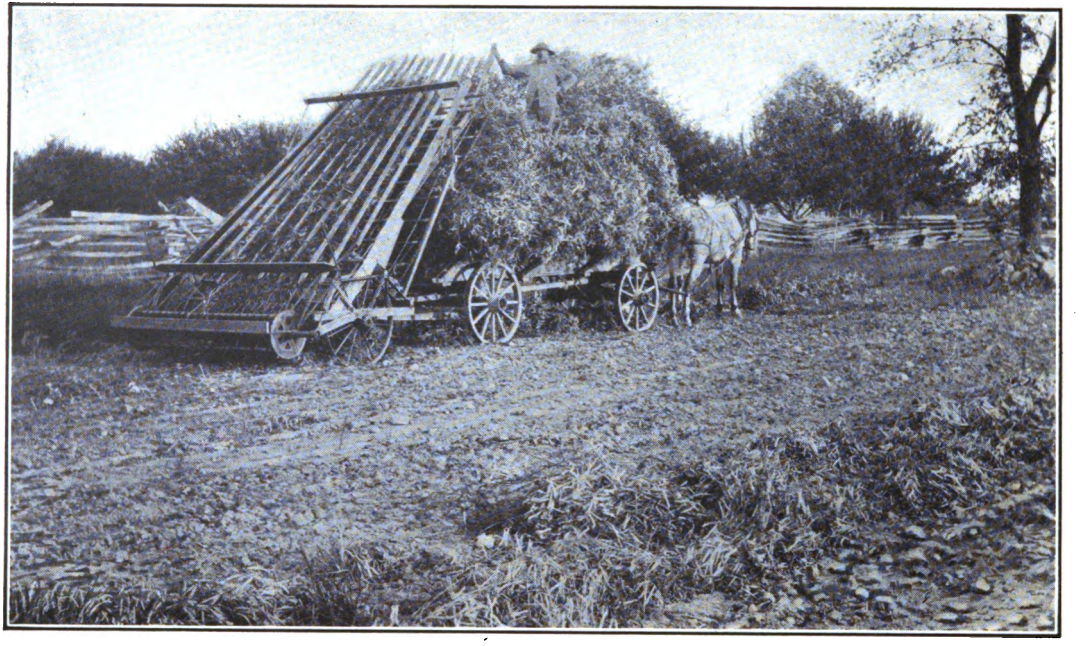

LOADING BEANS WITH A MODERN HAY LOADER (SEE PAGE 84).

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BEAN CULTURE

A PRACTICAL TREATISE ON THE PRODUCTION AND MARKETING OF BEANS, WITH A SPECIAL CHAPTER ON COMMERCIAL PROBLEMS BY ALBERT W. FULTON. A BOOK FOR GROWER AND STUDENT ALIKE.

By

GLENN C. SEVEY, B. S.

Associate editor American Agriculturist weeklies

ILLUSTRATED

NEW YORK

ORANGE JUDD COMPANY

1907

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PREFACE

Volumes have been written on varied farm crops approaching the subject matter from as many different points of view. The student or the everyday farmer may delve as deeply as he may wish into the technique of cereal production, live stock management, etc. Books can be found on practically all lines of farm activity from the growing of wheat in an extensive way; and so of the various field, fruit, vegetable and special crops and live stock undertakings until one's thirst for agricultural information is thoroughly quenched, and his appetite for farm literature satiated. But surprising though it may seem, the bean, admittedly important in our agricultural economy, has not, to the writer's knowledge, ever been dignified by having a book given over exclusively to it. Practically the only information one can get on the subject is from incomplete reference in other works which treat only one particular phase of the subject. The United States Department of Agriculture and the various state experiment stations have worked out problems relative to beans and bean culture, some of which have been published; others have not. The agricultural press has printed considerable matter from time to time on the subject.

It is the author's object to bring together the many individual accounts, perhaps complete in themselves, and combine them in such a way as to give in a nutshell to those interested, authoritative and detailed information relative to beans. The

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aim has been primarily to make the book practical for the man who wishes to grow a maximum crop at a minimum expense, and second, to make the volume scientifically accurate for the student and teacher—in brief, a volume which will prove invaluable to the everyday bean grower and one which will go on the desks or in the libraries of students and teachers as a valuable reference book.

The author brings personal knowledge into the work, for he was born and reared in the heart of the commercial bean growing district of Michigan. His father grew annually 10 to 30 acres of beans and the first real hard back-aching work he ever did was done in the bean field at harvest. During his senior year in the Michigan Agricultural College, he gave special attention to the subject and worked out a few experiments along the line of accumulation of nitrogen from the soil air by the bean plant. Finally before starting the volume in question, he again visited Michigan and the large commercial sections of New York and has since gone very thoroughly into the bibliography of the bean plant.

The very interesting chapter entitled "Markets and Marketing," or the commercial side of bean growing was prepared by Mr. A. W. Fulton, managing editor of the Orange Judd weeklies. The writer also wishes to acknowledge the aid of such works as Prof. J. L. Stone of the Cornell University experiment station in his bulletin on "Commercial Bean Growing in New York;" Prof. H. C. Irish of Missouri, Dr. F. H. Chittenden of the United States Department of Agriculture and Prof. R. A. Emerson of Nebraska. Deductions and remarks made by these authorities are quoted freely in the book, as

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well as the conclusions of many others who have given particular consideration to the bean plant. A few of the illustrations have been copied from other publications in which case full credit is given. The New Hampshire Agricultural College at Durham has furnished several halftones of different varieties. One interesting photograph was contributed by the Minnesota experiment station. Other illustrations than appear were planned, but the fire which destroyed the publishing plant of Orange Judd Company, took with it both halftones and original photographs which could not be duplicated.

Finally, if readers note any errors, which almost invariably creep into a work of this character, they will confer a favor upon the author by reporting them to headquarters so that corrections can be made in subsequent editions.

Glenn C. Sevey.

January, 1907

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UNIV. OF CALIFORNIA

BEAN CULTURE

CHAPTER I

HISTORY AND BOTANY

The common bean, (*Phaseolus vulgaris*), is a member of the leguminosae family, that class of plants which offers to man one of the richest heritages known to agriculture. For, as generally known, it is members of this family which have under proper conditions, the ability to acquire nitrogen from the soil air. Therefore, since nitrogen is one of the three elements which farmers most frequently buy at high prices to feed their crops, the great economic importance of beans or other nitrogen gathering plants is at once apparent. This quite outside of the money value of the crop when sold or fed.

The origin of the kidney or common bean is not definitely known, though leading authorities agree it originated in tropical America. Beans were very common among the Indians. Three weeks after his first landing in the new world, Columbus saw near Nuevitas in Cuba, fields planted with " faxones" and "fabas" very different from those of Spain. Faxones or fexoes were, as Navarrete says, "the same as frejoles or judias." These are Spanish names for kidney beans which the Portuguese called "Feijaos." Oviedo (1525-35) speaks of the fesoles, or in Aragon judias. From this time (1535) onward, nearly every writer who mentions plants cultivated by the Indians mentions together, or in close connection, maize, beans and pumpkins. It appears (Lescarbot, 1608) the Indians planted corn

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in hills and between the kernels of the corn they planted beans which were marked with various colors.

M. De Candolle is not free from doubt as to the origin of *Phaseolus vulgaris*. He finds, (1) that this species was not cultivated in ancient times in the East Indies, the southwest of Asia, or Egypt; (2) that we are not absolutely certain it was known in Europe before the discovery of America; (3) that at that epoch the number of varieties suddenly increased in the gardens of Europe and all authors began to speak of it; (4) that the majority of species of this genus are found in South America; (5) that seeds which ordinarily belong to this species have been found in Peruvian tombs at Ancon on a date somewhat uncertain, mixed with other species, all of which are American. It seems conclusive that almost innumerable varieties of *Phaseolus vulgaris* were cultivated by the natives of America before the coming of Europeans. For still further notes on the origin of the bean plant consult De Candolle, *Nativity of the Bean*; Gray and Trumbull, *Origin of Cultivated Plants* and *American Journal of Science*, (Vol. 26, p 130).

Commercial field beans were probably first grown in Orleans county, N. Y. This was in comparatively recent time. It is said* that in 1836 Stephen Coe brought from the eastern part of the state into the town of Yates, Orleans county, a single pint of beans. He planted them and from the successive products of three years his son T. H. Coe, in 1839 raised a small crop of beans and sold a load of 33

*History of the Bean Industry by S. C. Bowen.

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bushels to H. V. Prentiss of Albion who was the only man in the county who could be induced to buy so many.

Beans are exogenous plants, that is, outside growers, the new tissue forming near the outside of the stem and thus enlarging the diameter of the plant. They are also dicotyledonous, that is, have two cotyledons. The seeds contain no endosperm or albumen and exclusive of the coats consist entirely of embryo. The kidney bean is an excellent example of the structure of a two cotyledoned embryo. After the bean has been soaked in warm water for several hours the coats may be easily removed. The two fleshy cotyledons (see Fig. 2) are then often separated from each other save at the point where the radical or caulicle (a) is seen projecting like a blunt spur. Carefully breaking away one of the cotyledons a side view of the radical and plumule is secured (b), the former of which was partially and the latter entirely embedded between the cotyledons. The plumule plainly exhibits two delicate leaves on which the unaided eye may note the veins. These leaves are folded together along their mid-ribs. The cotyledons are carried up into the air where they become green and constitute the first pair of leaves of the plant. The second pair are the tiny leaves of the plumule just described, between which is the bud, whence all the subsequent aerial organs develop in succession.

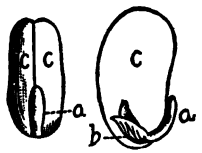

FIG 2
THE BEAN SEED.

Different types of beans.—Numerous species of beans are known. However, agriculturally they can

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be divided into the following types: (1) The Kidney bean (*Phaseolus vulgaris*) which comprises all the common, field, garden, snap and string beans, both bush and climbing; the common name in French for this species is haricot. (2) Lima or Sugar beans (*Phaseolus lunatus*), a native of South America, requires a long season and produces large flat seeds. Formerly the plants were tall and climbing, though dwarf forms are now common. (3) The Broad bean (*Vicia faba,*) often referred to as the bean of history, is an erect growing plant. It is believed to be a native of southwestern Asia. The seeds produced are flat, large and angular. Varieties of this type are grown largely in Europe for feeding animals. They can be grown to full maturity and the beans used as a forage, or ground to a meal. In the latter case the plants are cut a little before full grown. A long season and a cool climate is required for this plant. In Canada, Robertson's mixture is often made by planting these bean plants with corn to be used in the form of silage. (4) Soy or Soja bean (*Glycine hispida*), used largely for forage, is a native of China and Japan. It is an erect, bushy and hairy plant, produces small pods in clusters and rather small seeds which closely resemble peas. (5) *Dolichos,* a genus which differs from *Phaseolus* in technical characters, includes 40 to 50 species of which only a few forms are in cultivation in the United States. *Dolichos japonicus* is a fine ornamental vine and *Dolichos sesquipedalis* produces very long vines upon which are grown slender pods bearing narrow beans. There are numerous other species of this genus none of which are of commercial importance in this country. The Scarlet Runner (*Phaseolus*

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multiflorus) is grown mostly for ornament. In addition to these. Bailey* tells us of *Phaseolus radiatus* which is prized in Japan and has been introduced into the United States as Adzuki bean. *Vigna sinensis*, known in North America as cowpea, is often called a bean. The Velvet bean of the south is a *Mucuna*. The Jack bean is a *Canavalia*. The Sea beans of the Florida coast are seeds of various tropical leguminous plants transported by ocean current. The Locust bean, found on confectioners' stands and sold as St. John's bread, grows naturally on the shores of the Mediterranean sea where it is fed freely to cattle and is often eaten by the poorer classes of people. The scientific name is *Ceratonia siliqua*.

In the 1905 report of the Rhode Island agricultural experiment station, Dr. H. J. Wheeler makes special reference to *Phaseolus mungoradiatus*. This, he says, yields heavy crops in Rhode Island, is easily grown, ripens its seed perfectly in that climate and on account of its ability to gather nitrogen from the air can be grown with a minimum expenditure for manure. If ground and fed to fowls or other farm animals it may be the means of materially lessening the expenditure for the highly concentrated feeding stuffs of which eastern farmers are prone to buy too many. It is being grown by the college for distribution among the farmers in Rhode Island.

*Cyclopedia of American Horticulture, Vol 1, p 135.

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CHAPTER II

CONDITIONS AFFECTING GROWTH

Heat, moisture, air.—Beans, like other plants, require certain quantities of heat, moisture and air before any growth whatever occurs. Few plants with which the farmer has to deal make greater demands on all three of these agencies than beans. While other crops may demand nearly equal amounts of moisture, they are not as fussy about the demands. Beans soon lose heart in a drouth. This fact alone has been one great difficulty in the way of the success of bean growers. Many farmers are unable to carry the beans through a protracted drouth, particularly if this occurs at the time of fruition. The same general remarks hold true, though in perhaps a less degree, with heat and air conditions, as related to the growth of the bean plant. It is encouraging to note that farmers are rapidly learning to control these conditions in a degree, by adopting such cultural methods as will have a tendency to offset the unfavorable influences. Here it is that good judgment on the part of the grower comes into good play in determining the best methods to pursue, under the existing conditions presented with the season.

Conserving soil moisture is one way by which the farmer may thwart the attempt of an untimely drouth to destroy his bean crop. Among the things recommended to conserve moisture are: (1) Fall plowing; (2) early spring cultivation; (3) soil mulches; and (4) frequent cultivation so long as

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roots are not disturbed. Cultivation is especially necessary and should be frequent in the spring and after rains. The general practice is to cultivate deep and often early in the season, and shallow and less frequently as the season advances.

Importance of soil temperature.—The roots of plants can in no way take up plant food from the soil without proper soil temperature. Ebermayer's observations indicate that growth does not begin with most cultivated crops until the soil has attained a temperature of 45 to 48° F. and it does not take place most vigorously until after it has reached 68 to 70°. It is at its maximum when the temperature is 98°. J. B. Reynolds reports* that the best soil temperature for bean growth is 90°.

The seeding of general crops should not begin until the thermometer will show the temperature of the soil at the depth of planting well towards 70° F. during the warmest portion of the day. A still higher temperature would best be waited for in the case of beans. It is a conceded fact that the more quickly seeds germinate after they are placed in the soil, the higher will be the percentage of seeds growing and, as a rule, the more vigorous will be the plants.

It follows, therefore, that the practice of thoroughly preparing the seed bed before sowing or planting must have the effect of decreasing the capillary rise of cold water from below and its loss by evaporation from the soil. This then would tend to concentrate the sun's heat in the seed bed itself, first, by lessening its rate of conduction downward, and second, by diminishing its loss by lessening the

*Ontario Agricultural college, Rpt of 1903.

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evaporation. In the spring, then, early and thorough preparation of the seed bed tends to make the seed bed warmer; it diminishes the loss of soil moisture; it increases the formation of nitrates, thus making the soil richer; it hastens and makes stronger the germination and enables one or more crops of weeds to be destroyed before the crop is up ready for cultivation. Hence there is much to gain and little to lose in thorough preparation of the seed bed before planting.

Air conditions.—Fortunately those conditions which favor conservation of soil moisture also contribute in a general way to favorable aeration of the soil. Cultivating to conserve soil moisture admits light and air both of which are valuable to the plant. Interesting observations are reported by Eberhardt* relative to the effect of humid air on bean plants. In his experiments he found that humid air increased very materially the upward growth of the bean plants, though the diameter of the stem was diminished. There was a tendency greatly to increase the leaf surface and diminish the chlorophyll contained in the leaves, as well as greatly to reduce the root system. On the other hand, dry air checked the growth and development of stems and leaves, increased the diameter of the stem, diminished the leaf surface and greatly increased the number and distribution of the roots.

Electrical influence on beans.—Experiments in Germany by Prengshein ** showed that the increased production in beans on plats under electrical influence was over 30 per cent. On potatoes the influence was but 7 per cent. F. Paulin*** tells us that

*Compt Rend Acad Sci, Paris, 131, 1900.
**E S R, Vol 16. ***France, 1903.

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the yield of beans and peas under the influence of electricity was nearly doubled. The experiment was made by a mechanical device of rods, suitably connected with wires and buried in the ground, deep enough so that tillage would not be interfered with. C. Flammerion* experimented for a number of years with varying results with beans planted between copper and zinc plates, and buried in the ground, and connected with a Leclanche cell. The contradictory results were attributed to different conditions of atmosphere, moisture and temperature. In general he concludes that the current exercises beneficial results in the stimulating of the growth of beans.

Copper sulphate effects.—A number of experiments** were conducted to determine the effects of copper sulphate on different plants. The sulphate was applied to soil in plots for two years in succession at the rate of 40, 80 and 100 grams a square metre of surface without injurious effects on fruit trees and strawberries. However, considerable injury resulted when like amounts were applied in the field to bean plants. It should be remembered that the deduction from this experiment in no way argues against thorough spraying with Bordeaux to prevent fungous diseases of the bean plant. Bordeaux as mixed for bean spraying results in an almost infinitesimal amount of copper sulphate on the individual bean leaves.

Conditions affecting bean cooking.—K. de Vries*** tells us that the ease with which beans and peas cook up, varies much according to the fertilizer used for the crop. He finds that early sown peas or

*France, 1902.
**E S R, Vol 16, p 133. ***Deut Londw Presse, 28, 1901.

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beans are apt to cook with difficulty on account of the cold and moisture in the spring as a result of which, they are not furnished with sufficient nitrates by the action of nitric ferments. He recommends that some nitrate of soda be applied to both peas and beans at the time of planting to insure a product which will be easy to cook and which should, therefore, bring a higher price in special trade.

Reproductive powers.—So far as the practical bean grower is concerned, beans reproduce themselves by means of seeds. However, it is interesting to note the work of Arbel W. Clark* in the regeneration of the epicotyl in beans. Cotyledons were planted with a small piece of epicotyl left attached, and it was found that the whole plant was regenerated. This took place with a whole cotyledon and only a piece of the cotyledon was left intact, indicating that regeneration is not wholly dependent on the food supply. The author concludes that regeneration of epicotyl of beans and peas is dependent more on the age of the tissue than on the amount of food supply at hand. Dr. B. D. Halsted** reports experiments along the same line. In his work with bush beans a portion of the cotyledons was removed. Such seeds germinated more quickly than normal beans, but the plants from the whole seeds made much the better growth. The experiments indicate, according to the author, a method of producing dwarf varieties.

Beans self fertile.—Experiments by Doctor Halsted*** show conclusively that bush beans are self fertile. Prof. R. E. Emerson**** reports that Kidney beans are perfectly self fertile. Various crosses

*Mich Rpt Acad Sci, 1, 1904, p 80.
**E S R, Vol 14, p 578. ***E S R, Vol 14, p 548.
****Neb Sta Rpt, 1901, pp 30-49.

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were made of the racial hybrids. All beans reproduced showed little variation in the first generation but pronounced variation in the second and third generations and appeared fairly well fixed in the fourth and fifth. The characters of the two parents were usually reproduced in the hybrids, though occasionally new or atavistic tendencies were observable. When green and yellow podded races were crossed, the first generation hybrids had green pods, yellow and intermediate colors not appearing until later generations. When semi-dwarfs and dwarfs were crossed, the first generation hybrids were all semi-dwarfs, strictly dwarf not appearing until the second generation.

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FIG. 3—THE USUAL METHOD OF PULLING BEANS (SEE PAGE 82)

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CHAPTER III

SOILS AND FERTILIZERS

Fertile soil.—In a general way it is quite freely admitted that a fertile soil must contain certain elements in order to mature crops. These substances are potassium, calcium, magnesium, phosphorous, iron sulphate and chlorine. If any of these elements are absent from the soil the crop will not develop properly. These different substances are combined in the soil in a great variety of ways. In just what form they should be combined to insure a bountiful crop of beans is not accurately known, but while it is a common impression that beans will grow on any soil, however poor, the fact remains that if one expects to harvest a profitable crop, reasonably productive soil must be provided.

Good bean soil.—The old saying in connection with worn-out land "too poor to grow white beans," has too long given the wrong impression. Soils loaded with organic matter are undesirable for beans because of the tendency of such soil to produce a rank growth of vines, perhaps at the expense of seed production, or at best the beans will ripen unevenly, and will be more subject to fungous diseases. All leguminous plants do well on limestone soils and beans are no exception to the rule. Professor Stone says* rather heavy clay loams if well drained, or gravelly loams if there is considerable fine silt and humus among the gravel, and if they are made rich, will grow profitable crops of beans. Heavy clay

*N Y Cornell Exper Sta, Bul 210.

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and sandy soils are less desirable. Lands that will produce both good corn and wheat will produce beans, though the beans will not thrive on as heavy soil as wheat, nor on as light soil as corn. The crops succeed wonderfully well on inverted clover sod.

According to experiments of Doctor Halsted,* beans yielded on the whole better on old land than on new, though they were slightly more susceptible to disease when grown on old land. More and larger tubercles are usually found on beans grown on old bean lands than where grown on new.

Soil as adapted to variety.—Most interesting data on this subject are furnished by Cornell** in the compilation of results obtained by different farmers on various soils and with varieties. The varying results obtained in the several sections throughout New York, suggest at once the question of adaptation of varieties to classes of soils. Further mention of this detailed report will be found in the chapter on varieties.

In these experiments the lighter grades of soil seemed to be productive of larger yields than the heavier grades both in a dry season like 1900 as well as in a more normal season like 1901, but it seemed to make little difference in the relative yield of the varieties whether the soil was light or heavy. The deductions from these experiments are not entirely satisfactory, though Professor Stone gives it as his opinion, based on general observation, that the White Marrow, Yellow Eye and Kidney beans require stronger and more fertile soil to produce a satisfactory crop, than do the pea or medium varieties. He says it is evident that in the present condi-

*Soc for promotion of agr. **Science, 1900, pp 119-129.

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tion of the farms of New York state, the small white varieties will outyield the larger beans in a majority of cases.

So far as the practical bean grower is concerned with these experiments of adaptation of variety to soil, the important facts to bear in mind are, first, that there is a great difference in the productiveness of the different varieties of beans on a given soil; second, that the results obtained in a variety test in another locality cannot be taken as a specific application on one's own farm, and this even though the farms are adjoining. It costs in labor $1 to $3 according to circumstances to make a careful test of six to eight varieties of beans, harvesting them separately so as to get definite results. The difference in yield of one variety over another on a single acre will often pay this expense several times over. There are many farmers who, in the beginning, were positive they were growing the best variety of beans, but after the co-operative test at the Cornell station changed to another variety much to their profit.

Fertilizers to use.—The best fertilizer to use will depend greatly upon such conditions as nature of soil, previous treatment, season, etc. Beans which do not ripen as they ought, may be lacking in phosphoric acid. If the land is already rich in nitrogen, nothing but the mineral elements had best be used. Broadly speaking, clay soils will need less potash than sandy soils. It is a general custom among successful bean growers to supply very little nitrogenous fertilizers to the bean crop, taking it for granted that beans, being a leguminous crop, will appropriate a large part of the necessary nitrogen from the air. From some reliable experiments it

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appears that applications of phosphoric acid may lead to a profitable increase of yield. The bean plant, especially when young, seems to be particularly susceptible to injury from the liberal use of potash in dry seasons. The fertilizer should be thoroughly mixed with the soil to guard against such injury. In fact, whatever fertilizers are used, it is well to bear in mind that a harmful effect by delaying or even entirely preventing the germination of seed will almost invariably result, if the fertilizer comes in contact with the seed.*

Considerable work has been done in the line of determining what fertilizers are best and under what conditions each will succeed. The results of experiments with beans by C. Von Swelhorst** indicate in general that a good supply of bean food tends to develop a strong, well developed root stem, with roots growing to a greater extent than when plant food is limited. For this reason he believes that heavy fertilized crops are better able to withstand drouth than those having received but slight applications. His deductions are the more significant when one recalls the fact that beans are very apt to suffer at the end of the season from drouth.

Dr. L. F. Kinney*** found that dissolved bone black, sulphate of potash, muriate of potash, sulphate of ammonia and nitrate of soda, when tried out on 12 different varieties of bush beans, resulted in yields favorable to dissolved bone black. Sulphate of potash came second as productive of the best yields, and muriate of potash third. The nitrogenous fertilizers proved unprofitable.

*U S dept of agri, div of botany, Bul 24.
**Jour landw 50, 1902, pp 91-104. ***R I Rpt of 1890, pp 154-5.

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G. Septh* reports that superphosphate, muriate of potash and cottonseed meal, in different combinations and varying amounts, were tested on Early Valentine beans. Combinations containing nitrogen gave uniformly the best results, the highest yield being obtained with a mixture applied at the rate of 400 pounds of superphosphate, 100 pounds nitrate of soda, 100 pounds muriate of potash and 100 pounds cottonseed meal, an acre. Doubling the amounts of fertilizer produced no considerable increase in yield.

C. A. Mooers** states that in field experiments with beans profitable results were obtained by the application of quickly available phosphoric acid and nitrogen. Nitrates increased the vigor of the plants while phosphoric acid hastened the maturity. After careful experimentation, E. B. Ferris*** declared that best results were obtained with the following application: 27 pounds cottonseed meal, 13 pounds dried blood, 60 pounds acid phosphate and 25 pounds kainit an acre. G. Truffant and Denaiffe**** say that the best bean growing fertilizer will analyze 4 per cent nitrogen, 8 per cent potash and 17 per cent phosphoric acid. The soil used in this experiment was rich in organic nitrogen and lime, but relatively poor in potash and phosphoric acid. Dr. H. J. Wheeler***** finds that lime is apparently slightly helpful to the white bean when sodium and potassium are present in chlorids, but where the carbonates are used it seems to be injurious. The common white bean, therefore, thrives upon a very acid soil, a fact which may help to explain the New England idea

*Ga Exper Sta, Bul 14, pp 81-2. **Univ of Tenn Record, 1904, pp 31-2. ***Miss Exper Sta, Bul 79, p 35. ****Jour Soc Nat hort, France, 1900. *****R I Exper Sta, Bul 104.

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that it is a good crop for a poor soil. The average crop of beans was nearly five times as great where the full allowance of potassium salt was used as where the full amount of sodium salts was employed. A fractional application of potassium salts made in addition to full quantities of sodium salts had a most beneficial influence upon the yields.

Co-operative fertilizer tests on 10 farms in Sterling* include the following elements in different combinations: superphosphate, muriate of potash, kainit, gypsum, and sulphate of iron. These were used in varying quantities; the deductions were that as good bean crops can be grown with commercial fertilizers as with barnyard manure, and that there are no marked differences in the use of one kind of fertilizer over another. The yields with kainit and muriate of potash were equally good. Sulphate of iron effects were very erratic.

During the seasons 1899-1900 many farmers in New York undertook experiments with commercial fertilizers on beans. Drouth occurred during both seasons and the crops were very much affected. The result of these tests conducted by Professor Stone** are given herewith. The plats were one-tenth or one-twentieth acre each, according as the farmer desired to test moderate or heavy applications of fertilizers. Usually the plats consisted of three to six rows, extending far enough into the field to secure the desired area. The plats were as nearly alike in area, character of soil, etc. as was possible to secure. They were treated exactly alike, except as to the fertilizer applied. In the appended table the letters K, N and P stand respectively for potash, nitrogen and phosphoric acid.

*Trans Highland and Agri Soc, Scotland, 1895. **N Y Cornell Bul 210.

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TABLE OF FERTILIZER TEST

No. of Plat	Fertilizer	Application
Plat 1	K	15 lbs Muriate Potash.
Plat 2	N	20 lbs Dried Blood.
Plat 3	P	30 lbs Acid Phosphate.
Plat 4	Blank	No Fertilizer.
Plat 5	NK	mixed { 15 lbs Muriate Potash. 20 lbs Dried Blood.
Plat 6	PK	mixed { 15 lbs Muriate Potash. 30 lbs Acid Phosphate.
Plat 7	NP	mixed { 20 lbs Dried Blood. 30 lbs Acid Phosphate.
Plat 8	NPK	mixed { 20 lbs Dried Blood. 15 lbs Muriate Potash. 30 lbs Acid Phosphate.
Plat 9	S	Stable manure

The following table gives the results obtained by the different farmers who undertook the work. Under soil H is heavy, L is light, M, medium. K means potash, N, nitrogen, and P, phosphoric acid.

TABLE OF RESULTS FOR TWO YEARS

No. of Exp.	Yr	Soil	K	N	P	Bl'k	K.N.	K.P.	N.P.	KNP	Barn manure
4	1899	H	9.20	9.20	10.80	9.20	7.50	7.50	9.20	10.00	
5	"	L	24.80	20.36	22.98	18.14	22.18	20.76	17.53	19.35	
6	"	L	14.00	16.00	25.00	13.50	10.00	17.00	18.00	17.00	
7	"	M	22.92	25.00	25.00	22.92	29.17	29.17	25.00	22.92	
41	"	L	17.34	14.92	15.40	18.55	14.51	17.74	16.93	16.13	
4	1900	L	12.10	12.10	10.48	6.45	14.51	14.11	13.79	12.90	
9	"	L	14.40	15.23	15.42	16.36	16.92	18.51	19.56	19.75	20.58
10	"	M	12.90	15.43	20.56	13.09	15.11	17.09	14.61	13.71	13.53
11	"	H	12.34	12.35	21.66	13.35	10.84	16.63	20.16		
42	"	L	7.26	5.64	11.29	5.24	8.06	12.90	15.32	15.32	
43	"		14.47	15.23	15.44	16.37	16.89	17.88	19.58	19.79	20.49
Average			14.70	14.71	17.64	13.92	15.06	17.21	17.24	16.69	

A study of this table leads to no satisfactory conclusions. It seems that phosphoric acid in the form of dissolved South Carolina rock is more likely to give profitable results than applications of any other fertilizing material. Many of the farmers reported

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that the stand of young plants was injured by the fertilizers especially in the case of potash. The bean plants seem to be particularly susceptible to such injury. In dry seasons the danger from such injury is increased. It is generally believed, and these experiments seem to sustain the belief, that commercial fertilizers produce very little effect in dry seasons. Sufficient moisture must be present to dissolve and distribute the added plant-food through the soil or little benefit can be derived.

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CHAPTER IV

AS NITROGEN GATHERERS

Soil not dead but alive.—Until recently soil was considered dead, inert matter, but now we know it is teeming with life. It is full of countless millions of bacteria, some favorable to the farmers, some neutral, and still others unfavorable. One of the new problems of scientist and farmer alike is to learn more of the action and history of these bacteria. By knowing their character and mode of development it will thus become possible to encourage the growth of favorable ones in the soil, and hold back the unfavorable. We are coming to believe that in the soil there is a continual warfare among the hundreds of specific bacteria and that, as Darwin says, it is the survival of the fittest.

Only a few of these bacteria have been separated from their associates and studied sufficiently to know their life and character. Much has been done in the past few years with the particular form of bacteria closely united with leguminous crops, such as beans and clover. Hellriegel in 1888 published deductions made from his studies, which showed conclusively that great numbers of microscopic forms of life can be found on the roots of leguminous plants, forming upon them tubercles in which these organisms live and are enabled to draw from the soil air the free nitrogen which the plant so much needs. There are forms of tubercles which live on peas, beans, clovers, and other members of the legume family. The tubercles on the bean plant are exceedingly valuable friends to the bean grower.

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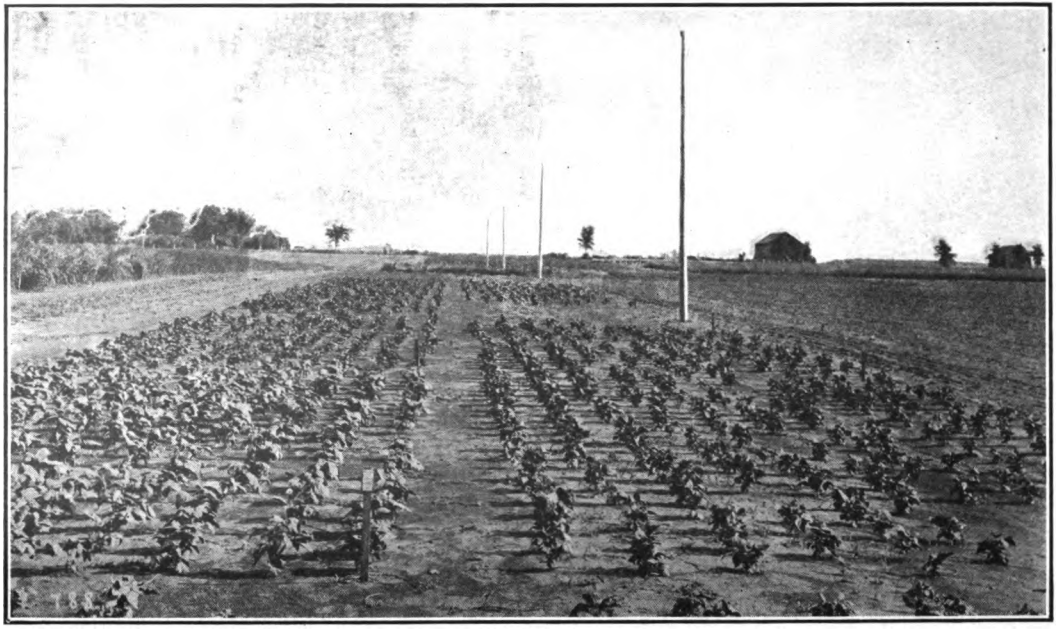

FIG. 4—BEAN PLOTS AT MINNESOTA EXPERIMENT STATION.

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In experimental work at the New Jersey experiment station, Doctor Halsted* found that in many instances there was a decided increase in yield of beans on soils where several successive crops of beans had been grown, over the yield grown on a soil for the first time. The roots of the plant growing on old ground were supplied with rather abundant tubercles, with the exception of a plat which was shaded. Here the tubercles were much less abundant. In the new soil the tubercles were usually almost entirely absent, and during days of thinning the plants (about 12 days after planting), almost none were observed. At the same time they were very abundant upon the plants in the old ground. This seems to indicate that the root tubercle organisms were present in unusual amounts in the old land, and in comparatively limited amount on the new land.

Pea and bean tubercles not identical.—Comparisons were made between the tubercles on the roots of beans and peas by Doctor Halsted, who found the differences in structure and external appearances were so striking as to suggest almost separate origin. The differences in root system of the two plants, however, would probably account for the difference in form of tubercles in a degree.

Artificial inoculations of beans with pea tubercle bacteria, by Nobbe and Hiltner** were made in 1900. Reciprocal inoculations were made on beans and peas with bacteria from the tubercles of each, the object being to ascertain the effect of the adaptation of the organisms to plants of a different genus than that from which they were originally secured. It

*Proc Soc Prom Agri Sci 1897, pp 78-81. **E S R, Vol 12.

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was found that if either plant was inoculated with germs from the tubercles of the other, some tubercles would be formed, but the organisms seemed to be without the power of nitrogen assimilaton. If the inoculation was continued a second season, or through a second or third season of cultures, the bacteria became nearly as efficient as those from the roots of the same genus. To the organisms resulting from such adaptations, the authors have given the name "crossed" or "crossbred bacteria." When inoculations with these crossbred bacteria were made upon their original host, they were found to have nearly lost their ability of nitrogen assimilation on the roots of that plant, showing little, if any, increased nitrogen content over non-inoculated plants.

Favoring tubercle formation.—Having the fact fixed that bean roots carry bacteria capable under proper conditions of assimilating nitrogen from the air, the next question comes, how can the bean grower facilitate accumulation. This may be done in two ways: First, succeeding beans after beans, and allowing nature to build up a strong colony of bacteria; or second, if artificial inoculation is practiced, cultures may be used, or soil from a field which has produced a crop of beans can be mixed with that in the field under consideration.

Much has been said relative to the efficiency of inoculation culture for legumes. The Department of Agriculture at Washington gained considerable notoriety through Doctor Moore in this connection. The various conflicting evidences which can be assembled warrant no specific and accurate deductions on what should be the practice of the farmer relative to bean cultures. It cannot be disputed

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that in some cases at least, marvelous results have attended the use of artificial inoculation. For instance, J. F. Derway of Chittenden county, Vt., grew in 1905, 20 acres of white beans on light, sandy, soil. He tried the cultures sent out from Washington, and treated 12 bushels of seeds, following the directions closely. Some of the beans were planted as soon as dry, the others were kept two or three weeks

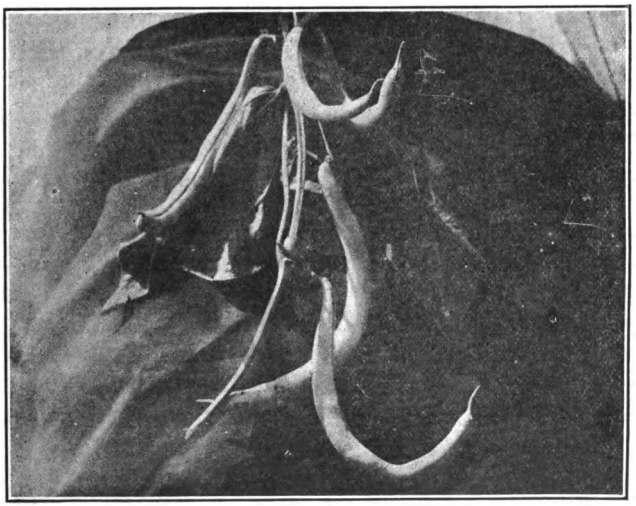

FIG. 5 —A PRODUCTIVE BEAN STALK FROM NEW YORK.

before planting. The last named lot which was left to stand three weeks after being soaked with the treatment, seemed to do much better than the beans planted immediately after inoculation. They made an exceptionally large growth of vines and were thickly podded. The roots bore many tubercles.

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This was not the case with the beans which he did not inoculate.

Halsted* reports that one plat of beans on new land which had received a dressing of soil from old bean land yielded equal to the best obtained where fungicides were used. In connection with this it should be remembered that the average yield of this inoculated plat was one half more than on the old bean land, which would seem to indicate that the latter was wearing out, in spite of the advantage of accumulation of tubercle germs.

Disfavoring soil inoculation.—On the other hand, the experiences of Edwin F. Dibble, the well known New York seed grower, rather discountenance the use of especially prepared bacteria cultures for the bean plant. He says:** "We purchased enough bean culture in 50 acre packages for several hundred acres of different varieties of beans, such as wax, green podded and white beans. We treated the seed exactly according to directions accompanying the package. The beans were planted by farmers on some two-score different farms located in Monroe, Livingston and Ontario counties, and western sections of New York. These are conceded to be three of the best bean counties in the state. In every case the culture did not give us or any of our growers one single bean more than we would have obtained if there had been no culture used, and on several fields, the tests where we planted seed treated with the culture, and untreated seed, the results were in favor of the untreated seed. That, in a

*N J Exper Sta Rpt 1890. **National Stockman and Farmer, Dec 1, 1905.

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nutshell is the history of our experience and the farmers of America can take it for what it is worth."

How and when to use cultures.—Karl Kellerman* has some interesting general deductions on manner and time of using cultures. He admits that the method of distributing practically pure cultures of nitrogen fixing bacteria, dried on cotton, has not proved entirely satisfactory, this owing to varying conditions of air during transit in the mails, and to certain matter connected with laboratory technique. It is argued that inoculation may prove advantageous: First, if the soil produces a sickly growth of legumes even though their roots show some nodules; second, if a leguminous crop has made a stand but gives evidence of failure, due to the absence of root nodules. Under such conditions it is advisable to apply the culture liquid by spraying, or better, by top-dressing the land with soil moistened with the culture liquid as explained in the directions sent with all packages. It is said inoculation is useless. First, if the legumes usually grown are producing average yields or the roots show nodules in abundance; second, if the soil is rich in nitrogen. It is neither necessary nor profitable to inoculate a soil rich in nitrogen since few nodules are formed under these conditions. Cultures of nitrogen-fixing bacteria are not to be regarded in the light of nitrogenous fertilizers, increasing yields under all conditions. The bacteria do not contain great supplies of nitrogen. If conditions are favorable, however, they render nitrogen obtained from the air available for the legume

*U S dept agri, Farmers' Bul 240.

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In the bulletin, Kellerman enumerates the instances when inoculation will be a failure. These are: First, if the instructions are not studied intelligently and followed carefully; second, if the soil is acid and in need of lime. Liming to correct acidity is as important for the proper activity of the bacteria as for the growth of the plants; third, if the soil needs fertilizers, such as potash, phosphoric acid, or lime. The activity of the bacteria in securing nitrogen from the air and rendering it available to the legumes will not take the place of such fertilizing elements as potash and phosphoric acid. It must be remembered that inoculation will not overcome results due to bad seed, improper preparation and cultivation of ground and decidedly adverse conditions of weather or climate. Before attempting to inoculate a new crop, the farmer should first inform himself thoroughly concerning the proper handling of the crop itself, otherwise failure is almost certain. Free publications on this subject may be secured by addressing the directors of various state experiment stations and the United States Department of Agriculture at Washington, D. C. Bulletin 270 of the Geneva (N. Y.) experiment station contains interesting deductions on the use of commercial cultures for legumes.

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CHAPTER V

VARIETIES AND WHERE THEY SUCCEED

It is at once apparent that this chapter must, when confined to a few hundred words, be from a botanical standpoint incomplete, since a sizable book could be written on varieties of beans alone, giving descriptions, characteristics, origin, etc. However, there are dozens of named varieties which are seldom heard of outside certain localities, in which the average bean grower has no interest. It is the mission of this chapter to give the standard varieties which have proved their worth, and will insure the average bean grower the best crop under given conditions. If one is looking for the characteristics of the several varieties of beans and their botanical relationship which have been put on the market, he cannot do better than consult the comprehensive work of Prof. H. C. Irish of Missouri which was issued in June 1901 in connection with the twelfth annual report of the Missouri Botanical Garden.

Standard field varieties.—Perhaps the most popular sort in commercial centers is the pea bean, variously known as Boston small pea, navy, true bean, white navy, white field, etc. The plants are, according to Professor Irish, 1 to 1½ feet high and produce numerous runners about 1 foot long, often spreading or trailing. The leaflets are deep green, 2 to 2½ inches long, roundish, ovate, slightly wrinkled; blossoms are white, pods yellowish green, 3 to 4 inches long. The seed is white with veiny markings. The famous Boston baked beans are prepared from

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this type. Whether called pea bean, marrow pea bean, white bean or navy bean the type is practically identical. There is a tendency to call beans navy in the West and pea in the East.

New York, one of the three leading bean-producing states, produces four varieties in a large majority. These are pea beans, mediums, red kidney and white marrows. Prof. J. L. Stone says,* "there are grown in the state seven or eight distinct varieties of commercial beans, and some of these have several

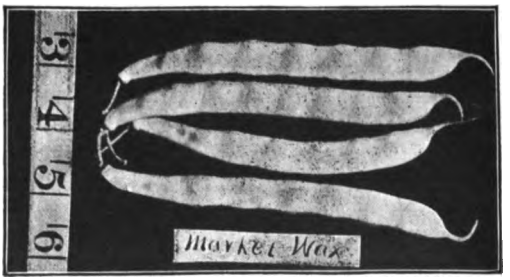

FIG. 6—MARKET WAX BEANS.

sub-varieties. These varieties are quite distinct from the vegetable or garden sorts that are grown for the canning factories or for sale in the green state. The varieties may be named as follows: Marrow Pea, Boston Small Pea, Medium, with sub-varieties, Day's Leafless Medium, Blue Pod Medium, Burlingame Medium, and White Wonder; White Marrow (with sub-variety Vineless Marrow), Red Marrow, Improved Yellow Eye, White Kidney, Red Kidney, and Black Turtle Soup."

*N Y Bul 210, p 236.

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The plants of the White Marrow are 12 to 16 inches high, strictly dwarf, vigorous, much branched, and compact. Leaflets are 3 to 3½ inches long and 2 to 2½ inches broad, elongated, taper pointed and much wrinkled. Pods are green, 3 to 5 inches long; the seed is white, uniformly oblong, abruptly rounding at the ends, very smooth and glossy; an early and quite productive variety. The plant of the White Kidney is strictly dwarf, 12 to 15 inches high and bushy; leaflets light green, 3 to 3½ inches long,

FIG. 7.—STRINGLESS GREEN POD BEANS.

2½ to 3 inches broad, scarcely wrinkled, quite thick and stiff; blossoms white; pods are green, 3 to 5 inches long; spur stout and nearly straight; seed is white and pale yellow about the hilum; a very old and reasonably productive variety.

Relative to standard commercial sorts, Prof. E. J. Wickson of the University of California writes: "In California there is only one bean grown on a commercial scale. This is known as a pea bean. It is a small, white, roundish bean which has been grown in California for the past 50 years. It has a very thin, transparent skin which sloughs off easily in cooking. As a commercial crop, however, it has been largely

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substituted by what is called the small white bean, which is understood to be the same that is known as navy in the East."

R. B. Dunning and Company writing from Bangor, Me., say: "There are practically only two varieties of pea beans raised in this part of the state. The one that is the most desirable and brings the highest price is called the Rice pea bean. It is a very small bean. The other variety is quite a bit larger and

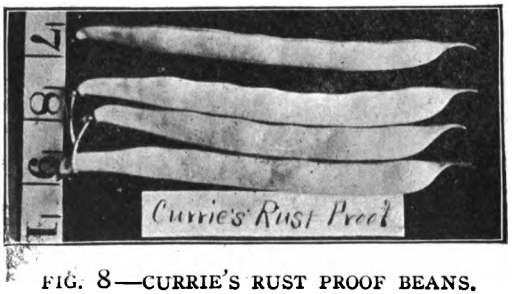

FIG. 8—CURRIE'S RUST PROOF BEANS.

compares more in size with the California bean. The last named are sold in this section for less than farmers can grow them, therefore, the reason for favoring the Rice bean."

Varieties for varying conditions.—Emphasis has already been laid on the importance of selecting the variety best adapted to a farmer's soil and local conditions. No man can tell accurately offhand what variety of the several standard field sorts will give best results for each farmer. The individual grower should ascertain this important fact for himself and while any of the varieties already named would likely give a fair crop, certain ones are doubtless better suited than others for the varying conditions

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presented. The co-operative experiments in New York,* conducted by Prof. J. L. Stone of the Cornell station are interesting in this connection. To gain information relative to the adaptation of variety to local conditions as well as to learn more of the agricultural value of different varieties, co-operative experiments were established among the farmers. Seeds of seven to ten varieties of beans were fur-

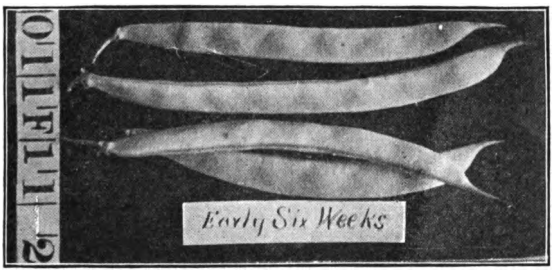

FIG. 9—EARLY SIX WEEKS' BEANS.

nished each experimenter. These were planted side by side under field conditions. They were given the same treatment and care, harvested and weighed separately so as to ascertain comparative yields.

The results showed very clearly that there is great difference in the productiveness of the different varieties when grown on the same soil and under the same conditions, so far as soil and conditions can be made uniform. There was scarcely an experiment in the whole list in which some one variety did not yield fully twice as much as some other variety. Again, there was not a variety that did not

*N Y Bul 210.

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in some experiment stand at or near the head of the list as regards productiveness and also at or near the foot of the list in other experiments. Some varieties headed the list much more frequently than others, while some produced the smallest yield more frequently.

The following table contains some generalizations derived from the experiments. It gives the number of times each variety was tested along side of a number of other varieties, the number of times it produced the largest yield, the number of times it produced the smallest yield, its average yield in bushels to the acre for each year tested and its general average yield to the acre for the whole number of tests.

DEDUCTIONS FROM TESTS

Varieties	No. of tests	No. of times produced largest yield	No. times smallest yield	Average for 1899	Average for 1900	Average for 1901	Only report 1902	Average of all
Marrow Pea	41	14	3	17.15	15.81	25.42	28.24	19.62
Boston Small Pea	33	5	2	0	13.88	25.52	0	18.82
Day's Leafless, Medium	34	10	6	0	13.40	28.29	14.12	19.55
Blue Pod, Medium	34	6	0	0	14.60	27.34	18.12	19.95
White Marrow	39	2	2	17.87	11.70	25.50	30.25	17.62
Vineless Marrow	17	0	6	0	8.39	0	0	
Improved Yellow Eye	27	1	5	12.19	10.80	0	14.33	
White Kidney	39	0	5	15.29	11.46	23.57	38.30	16.75
Red Kidney	39	1	12	12.15	11.12	21.26	29.32	15.15
Red Marrow	25	1	3	14.24	12.29	0	0	
Black Turtle Soup	13	4	3	12.40	0	0	0	

Thus the honors according to the preceding schedule are divided between Marrow Pea, Day's Leafless Medium, and Blue Pod Medium, with Boston Small Pea not far behind. Marrow Pea was in

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all the tests and headed the list the largest number of times of any variety, 14. It stood at the foot of the list three times and in the final average of all tests takes second place. Day's Leafless Medium headed the list the second largest number of times, 10, but stood at the foot of the list six times and took third place in final average. Blue Pod Medium which headed the list six times, is the only variety that did not fall quite to the foot and took first place in the general average of all tests. The

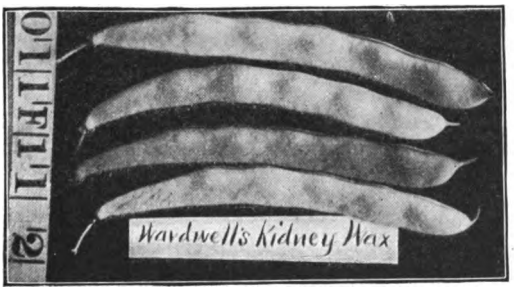

FIG. 10—WARDWELL'S KIDNEY WAX BEANS.

Red Kidney is probably the most largely grown of any variety outside of the pea and medium varieties. In the tests herein noted it produced the largest yield but once, while it produced the smallest yield 12 times. It is quite possible an undue proportion of the tests were conducted in localities more favorable to the small white beans. The Black Turtle Soup bean, though not largely grown, seems to be a large yielder in localities adapted to it, but very uncertain in others.

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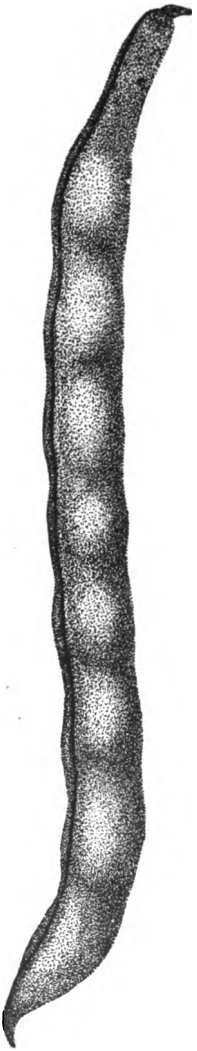

FIG. 11—OLD HOMESTEAD OR KENTUCKY WONDER.

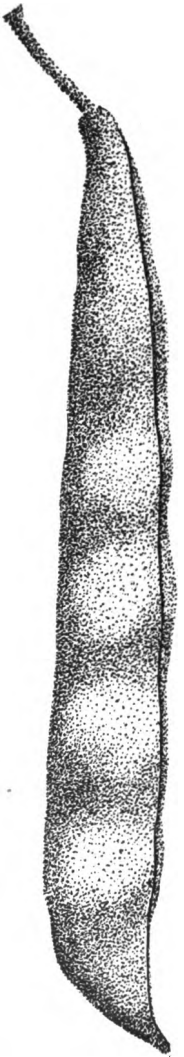

FIG. 12—BURPEE'S WHITE WAX BEAN.

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Favored varieties in different states.—The following notes are given on varietal tests in various sections of the country. However, it must be remembered that because Dreer's Improved Valentine produced the earliest crop in Alabama, it does not necessarily mean that variety should be planted for the earliest crop by every grower in the state. But it does give the farmer a cue from which to work; that is, it furnishes him an idea of the sorts which have given most satisfactory results. It will be noted that these notes from the various states include garden sorts as well as field. Still further varietal notes on garden varieties are given in the chapter on that subject. Unless otherwise indicated the tests quoted are those from the experiment stations in the respective states.

Alabama.—Tests (Bul. 1, p 8) of five varieties of beans with regard to earliness are reported. Dreer's Improved Valentine required but 42 days to be ready for the table; others graded up to 68 days. Tests (Bul. 51, pp 7-8) in 1893 resulted in Henderson's New Bush Lima being the earliest and most prolific. Further references of varieties in bulletins 7 and 20.

Arkansas.—Of three varieties of lima beans grown (Bul. 34, pp 122-123) Henderson's Early proved best. Stringless Green Pod, Extra Early Market, gave best results as snap beans and were highly recommended. Further variety tests reported in station report for 1895, p 122.

Colorado.—Notes and tabulated data for tests of 36 varieties reported, (Sta. Rpt. for 1899, pp 35-37). Earliest Red Valentine, Early Red Valentine, Early Mohawk, Long Yellow Six Weeks, Black Wax,

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Golden Wax, Speckled Cranberry, Case Knife, German Wax and Scarlet Runner are especially recommended. Broad Windsor (Sta. Rpt. for 1888, p 141), the well known broad bean of England, is well adapted to the state, being vigorous, healthy, and productive. Experiments (Bul. 26) in 1894 with eight varieties resulted in Golden Wax proving most satisfactory.

Indiana.—Tabulated data (Bul. 38, pp 18-19) for 28 varieties of wax beans. For family use Algerian Challenge, Golden-eyed Refugee and Yosemite Mammoth are recommended.

Kansas.—In 1890, 194 varieties were planted but only 19 survived the drouth. Henderson's Bush Lima, Dwarf Carolina and a local variety, Belcher, gave good results. (See Bul. 19, pp 198-201; also Sta. Rpt. for 1889, pp 131-135.)

Kentucky.—Descriptive notes on 30 varieties (Bul. 38, pp 15-17). The following are especially recommended: Improved Golden Wax, Crystal Wax, Valentine and Mohawk. Experiments in 1895, (Bul. 54) showed Wakefield to be the earliest and Improved Valentine and Speckled Wax, the most productive of bush varieties. With bush limas, Henderson and Jackson Wonder gave best results. Of the pole varieties, Kentucky Wonder, Yardlong, Large White, and Ford's Mammoth gave the best results.

Louisiana.—Twelve varieties of snap, five of lima, and four of pole beans tested and reported (Bul. 42). The following varieties of early snap beans are recommended: Early Mohawk, Extra Early Refugee and Extra Early Valentine. Henderson Bush was the most desirable variety of the lima strain. (See bulletins 36, 27, 3 and 22.)

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Montana.—Yields of 44 varieties of bush beans reported (Sta. Rpt. for 1903, pp 53-63). The heaviest yielding varieties in order were White Seeded Wax, Davis Wax and Long Yellow Six Weeks.

Michigan.—A report is given (Bul. 120) on 26 varieties of bush and 15 varieties of pole beans. Of the bush varieties, Cylinder Black Wax, Butter Wax, Mammoth Wax, Red Valentine, Flagolet and Victoria are recommended. Of the early beans Black Lima, Golden Champion and Golden Wax proved best. (See bulletins 79, 90, 144 and 131.) Prof. L. R. Taft recommends (Bul. 70) Aroostook, Burlingame, Snow Flake, and Jack Hat as field sorts.

New Mexico.—Notes on 27 varieties (Bul. 8). Boston small pea is recommended.

New Hampshire.—After careful experimenting, Prof. F. W. Rane recommends (Bul. 99) the following beans for New Hampshire; of green pod bush sorts: Giant Stringless, Green Pod Valentine, Stringless Green Pod and Early Six Weeks and Dwarf Horticultural; of bush wax beans: Wardwell, Kidney Wax, Currie Rust Proof Wax and Market Wax.

New Jersey.—In experiments (Sta. Rpt. for 1901) Fill Basket Wax was the earliest maturing garden sort and Jones Stringless Wax the most productive. (See also report for 1898.)

North Carolina.—Notes on culture and varieties of snap and lima beans, reported (Bul. 112). Varieties recommended are Extra Early Valentine, Golden Eye Wax and Dreer Pole Lima. (See also station report for 1895.)

North Dakota.—Eight varieties tested and reported on (Sta. Rpt. 1902). White Wonderfield gave the

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largest total yields; Brown or Swedish, the largest yields of marketable beans; Dewey Navy was the earliest.

Oklahoma.—The Valentine varieties recommended (Bul. 56) for green or snap beans; Large White Marrow and White Kidney for dry beans and Golden Wax, Dwarf Black Wax and Refugee Wax for yellow podded beans. (See also bulletin 9.)

Oregon.—Tabulated results (Bul. 22) given on 27 varieties. Southern Prolific stood the drouth best. (See bulletins 75 and 29.)

South Dakota.—Table given (Bul. 47) showing comparative results of yields of 20 varieties. German Wax, New Refugee Wax, Dwarf Black Wax and Giant Yosemite Wax, in the order named, led in productiveness.

Tennessee.—Notes on 14 varieties given (Bul. 5). The following are specially recommended: Bush Improved, Early Red Valentine, Extra Early Wardwell Wax and Golden Wax. (See also station report for 1892.)

Texas.—Tabulated data (Bul. 36) on 33 varieties: Extra Early Refugee, Golden Eye Wax, Cylinder Black Wax and Earliest Red Valentine were preferred.

Utah.—Report (Bul. 20) on tests of 28 varieties. Those especially commended are Speckled Wax for bush beans and Henderson Bush for lima beans. In 1891 (Bul. 10) tests showed the following varieties to be the best: Old Homestead, Kentucky Wonder, Early Mohawk, Challenge Dwarf and Wardwell Kidney Wax.

Tennessee.—Notes on 14 varieties given (Bul.5). given on eight varieties of early beans and 20 of dwarf

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beans. The earliest varieties were Marblehead Champion and Dwarf Earliest Wax. In 1890 the report of Prof. C. W. Minott (Sta. Rpt. for 1890) showed that for the field sorts Aroostook proved the earliest but the Improved Field set the largest number of pods.

Virginia.—General notes (Bul. 60) on several varieties of snap and lima beans. Extra Early Valentine is recommended as the best variety of snap beans and Henderson Dwarf for limas. In 1905 the field sorts with yields to the acre are as follows: Choice Navy, 23 bushels; Burlingame, 19 bushels; Choice Mediterranean, 14 bushels; Boston Pea, 12 bushels.

Washington.—Tabulated data (Bul. 42) on 19 varieties of bush and nine of early beans. Willing Pride produced the heaviest yield among the pole beans tested and Horticultural Lima the greatest among the limas.

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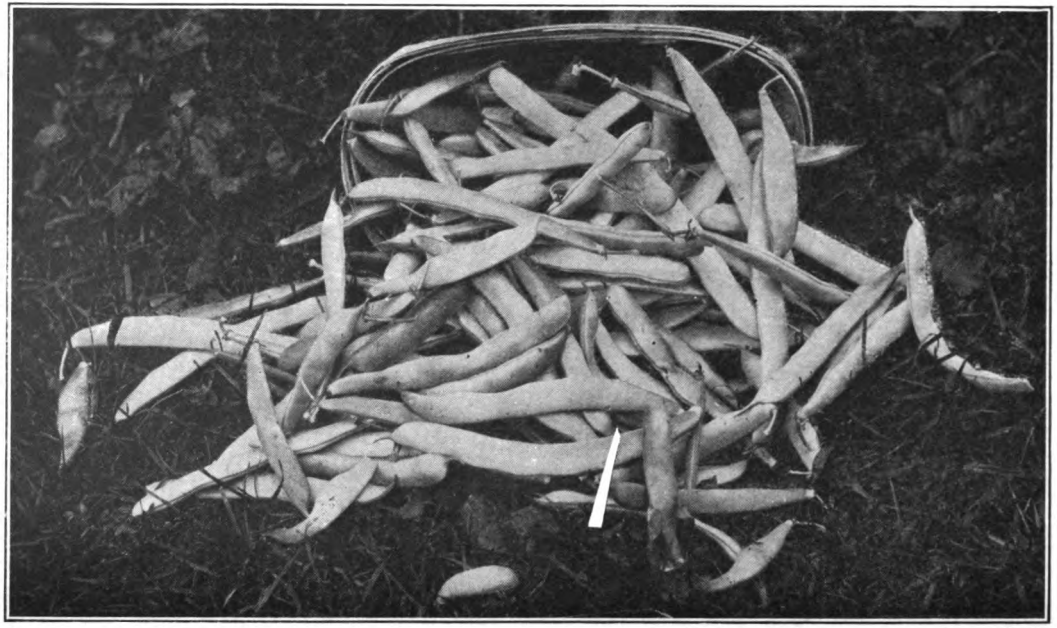

FIG. 13—A FINE SAMPLE OF WAX BEANS.

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CHAPTER VI

SEED SELECTION, BREEDING AND SEED GROWING

Getting the best seed.—Farmers as a class realize nowadays that none but the best seed must be put into the ground if they are to expect most profitable results. Careful seed selection means even more with beans than with wheat, oats or corn, for in addition to the advantages generally admitted in the use of strong, carefully bred seed, beans from a varietal standpoint have strong likes and dislikes. In some cases these are carried so far as almost to suggest capriciousness. A variety will succeed in one section in a certain soil and in the same section on slightly different soil will prove a failure. The bean grower must take these conditions as he finds them and humor the crop in its whims. Thus the importance in knowing not only the breeding of the seed but the likes and dislikes of the respective varieties.

The next question is: How can the farmer know or learn these varietal peculiarities for his immediate conditions? Here is where too many make a serious mistake. A farmer must not assume that because a variety succeeds on neighbor Brown's farm that it will succeed on his, even if the land in both places seems to be the same. The only safe way is for every man to try out several varieties for himself. This testing of varieties is clearly explained in Chapter III of this book.

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Buying the seed.—Four rules of great importance in securing good seed have been laid down. These are: (1) Buy only of reliable seedsmen, (2) buy the best grade of seed, (3) insist upon a guarantee of the percentage of seed which will germinate and (4) test the seed before planting. Poor and cheap grades of seed are really more costly than the high priced. It may be necessary to buy five or six bushels of low grade seed in order to secure as much seed that will germinate as is contained in one bushel of good seed. The farmer will save time, money and labor by buying the best quality of seed. At the same time he will avoid seeding his farm to weeds.

How to test seeds.—A guaranty of the quality of seed should be demanded from the seedsman, whose claims may be easily substantiated or disproved by a germination test. For this purpose a piece of blotting paper or of flannel may be moistened and folded together after placing a counted number, say 100, of the seed between the folds. The paper or cloth should then be laid on a plate, covered with another inverted plate and placed in a warm room. Several days should be allowed for the test. The germinated seed may be counted and removed from day to day, and at the end of the test the percentage of good seed may be easily computed. The standard of germination adopted by the United States Department of Agriculture for clean seed, harvested and preserved under favorable conditions and not over one year old, is for beans 90 per cent. This figure is based on results secured in a seed testing apparatus where the conditions of temperature and moisture could be controlled. When seed is tested in soil the germination is likely to be 10 or 15 per cent

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lower than this figure. As to the relative value of new seed and that two years old or more, it may be stated in a general way that fresh seed gives the best results. Generally speaking, experiments indicate that fresh seed should be used when it is desired to produce plants with a strong leaf growth.

Large or small seed.—Experiments reported by G. W. Churchill* for the years 1887-1888 show the results of planting large and small seed of Golden Wax beans. The yields both years favored the large seed. The plants which vegetated from each class of seed were counted each season daily from June 3 to July 2. Similar observations were made on Boston Dwarf and Early Aroostook beans. It was found that at first the small seed vegetated more rapidly, but that after a few days the plants from the large seed were more vigorous.

Bean breeding is an interesting subject but has not as yet reached a state of fixed principles, so far as the commercial bean grower is concerned. However, a few principles have been established which serve as a general aid to the farmer. Perhaps there are no plants more tractable in the hands of experienced bean breeders than beans. As in other plant breeding the ideal is established first of all. The breeder revolves the proposition in his mind and eliminates all the impractical and contradictory elements of it. Then he goes carefully through his bean fields, noting particularly those individual plants like the desired ideal and marks those plants which most nearly approach this ideal. The seeds of these plants are saved and planted in isolated positions. If the grower finds no promising

*N Y State Rpt 1899, pp 364-368.

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variations among his plants then he gets a variation in some other way. He will usually cross those varieties which are most like the proposed kind. Year by year he selects just those plants which he judges from experience will most surely transmit their features to the offspring. In this way the ideal is gradually approached.

The Rhode Island experiment station* has worked for several years to secure a variety resistant to frost. Three varieties of bush beans grown in the hotbed were exposed to frost and the seed from the most resistant plants saved. This seed was planted and the most vigorous plants which were most resistant to frost were saved and the seeds therefrom again planted. Some of the resistant seed sown in the open field, in comparison with the ordinary seed, showed more vigor in resisting cold and untoward conditions and made a stronger growth. The work will be continued. One interested in breeding beans cannot do better than read the interesting address of Prof. R. A. Emerson of Nebraska before the first annual meeting of the American breeders' association. Prof. Emerson begins by calling attention to the fact that a general purpose bean is an impossibility. The plant illustrates the value of special types for special purposes. Adaptation to local conditions is one of the first things to receive attention. A particular race of beans may be very good in one locality and worthless in another.

Bush beans for whatever purpose grown, should be erect and strong enough to hold their pods well above the ground to avoid rusting and discoloration if not

*Rpt for 1900, pp 251-252.

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harvested promptly when mature. Too often this characteristic is not found in either garden or field beans and this is suggestive of one line of breeding. Another very important feature in the case of field beans is breeding for productiveness. The pods must be abundant and well filled. The chemical composition of the bean seed will doubtless stand improvement and since beans are highly nitrogenous it would seem amiss to attempt to increase the starch contents at the expense of proteids. In snap beans the pod is a very important feature yet it cuts a very small figure in the case of field beans. However, for field beans the pod should be green, not yellow, tough and stringy rather than tender and stringless. An added reason for tough pods in field beans is the comparative ease with which they are thrashed. The cross fibers in the pod walls are the special agents for opening pods and scattering the seed. They have been bred out of some cultivated beans for obvious reasons, with the result, however, that these types are very difficult to thrash. A tender pod, particularly if it has been wet often after ripening breaks into pieces and adheres to the seed in thrashing, while tough pods still retain much of their original tendency to split along the sutures. Tender pods would be a great disadvantage in field beans.

Points of selection.—The first thing to do if one would improve any plant is to study the existing forms of that plant. Intelligent work in plant breeding must follow a systematic study of the varieties already available. It is not enough to know the general racial character of beans. Individuals of the same race vary greatly in vigor and productiveness, if

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not in the more fundamental characters of the race. Undoubtedly much can be done in the matter of race improvement by selection of productive individual plants. In fact this is a method in common use. Here, too, again Prof. Emerson* gives interesting deductions. He discusses bean hybrids in the light of Mendel's discoveries. This relates to habits of plants, stringiness of pods, toughness and color of pods, colors of flowers and seed. Stringiness in plants appears to be a dominant character in certain cases while in other cases intermediates occur in the first generation. In the majority of cases, stringiness has been dominant when the pistilate parent is stringless, and intermediates have occurred where the pistilate parent is stringy. In hybridizing beans it is necessary to remove the anthers before the flower buds begin to open, otherwise the seeds will be self fertilized.

Seed growing a specialty.—Few people realize the magnitude of the American seed industry. It is claimed by persons in a position to know, that fully 100,000 acres are now annually devoted to peas alone, and one-half as much more to beans for the express purpose of growing seed. Repeated tests have shown that seeds of many plants germinate more quickly when grown in relatively northern latitudes, if the samples which are compared are of equal age and strength. The bean, according to Bailey,** is not an exception to this rule. This fact has made a specialty for many seedsmen to grow seed for southern truck growers. The process is nothing out of the ordinary and really involves the same methods as though grown for commercial purposes. In many

*Neb Sta Rpt, 1905, pp 33-68.
**Survival of the Unlike, p 29.

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cases farmers contract with seedsmen to produce certain quantities. This is well illustrated by the case of J. L. White whose farm at Mount Morris, N. Y., the writer has visited. Mr. White had 85 acres planted to beans. The varieties grown were Black Wax Pencil Pod, and Red Valentine. The product was all contracted for before the seed was planted. He knew that he was to receive $2.25 a bushel for the Black Wax Pencil Pod and $1.75 a bushel for the Red Valentine. The first named are not quite as productive and hardy as the Valentines. The seedsmen usually supply the seed so that they can bank on the product.

The seedsman's position is well illustrated by the well known firm of D. M. Ferry & Co., of Michigan. Relative to the work, Mr. Ferry writes as follows: "We have a stock seed farm of several hundred acres on which we grow, select and breed up stock seeds of all varieties of beans and other vegetables. Our main crop of beans is grown for use by farmers under contract, and from seed we furnish. We inspect and rogue the different fields so that the crop as far as the farmer is concerned is on practically the same basis as the ordinary field crop, except that the price is agreed upon before the seed is planted. One year we entered the comparative profits of beans grown for the regular markets and for the seedsmen, with a result rather in favor of the latter." Mr. White is very pronounced in his opinion on this point. He believes that the seedsmen offer a much better proposition for the farmer than for the bean grower to depend upon local markets. It should be stated in this connection, however, that if all the farmers grew seed beans, the price would unquestionally go down.

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CHAPTER VII

INSECTS AND DISEASES WITH REMEDIES.

Enemies of bean plant.—The bean grower may expect his full quota of insect and fungous pests. The bean weevil and the anthracnose have driven more than one man out of the business and caused scores of others to regard the industry with apprehension. However, the determined and careful grower who uses all the agencies in his power to overcome the pests seldom, if ever, loses his crop through injuries by insects or fungi. It will be noted that as a rule those whose crops suffer most from these causes are the ones who use the least care in spraying at the proper time and are the least likely to take precautionary measures, of which there are many in the production of the best and surest crop.

The enemies of the bean plant are fungi, insects or bacteria. Fungi are minute plants often parasitic. The agents used to combat them are known as fungicides. The term insects is self explanatory and agents used to combat them are called insecticides. Insecticides are of two classes; those which carry a poison for leaf eating insects and those which kill juice sucking insects by contact. Bordeaux mixture is a good example of a fungicide and Paris green of an insecticide.

FUNGOUS PESTS

Anthracnose (*Colletotrichum lagenarium*), usually the most destructive disease of beans, is a fungus

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that was observed by Lindemuth in 1878. It is often wrongly called rust or blight. The disease originates in almost every case from the planting of diseased seed. If conditions are favorable it may

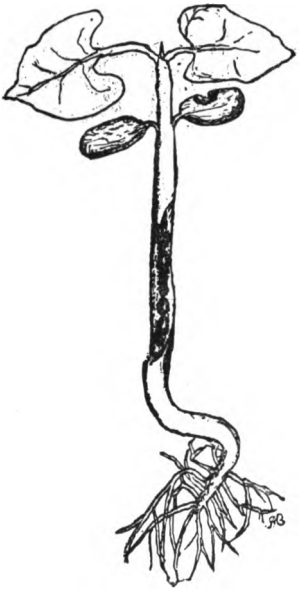

FIG. 14—BEAN PLANT AFFECTED WITH ANTHRACNOSE.

develop rapidly, killing the plants while yet quite young, or under other conditions it may not appear to any noticeable extent until the pods are well grown. The pods may become badly affected in which case the disease is known as pod-spot. Whetzell* says where it attacks the seedlings or young

*N Y Cornell Press Bul 4.

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plants it is very readily recognized by the brown or black sunken spots or pits on the stems and cotyledons. In many cases the disease eats through

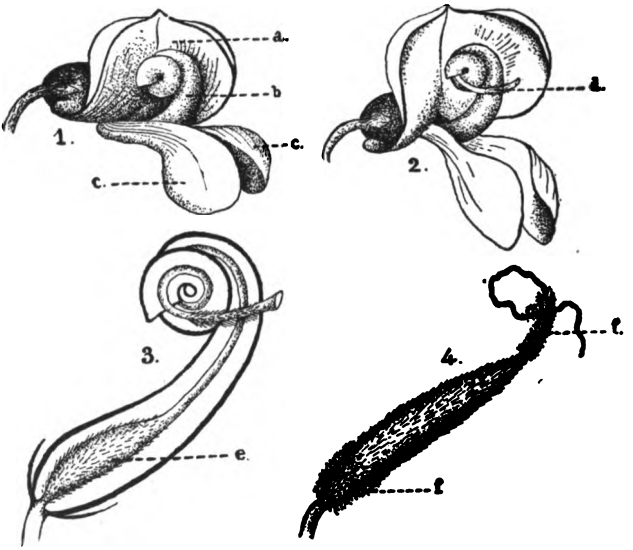

FIG. 15—SHOWING MILDEW OF LIMA BEAN.

I.—Blossom of Bean; a, standard. b, keel, enclosing the stamens and pistol. c, wing-petals. 2.—The same. Wing-petals depressed as by the weight of a bee, causing the style to protrude, d. 3.—The same enlarged. Petals and stamens removed and keel cut open to show the style coiled inside. e, ovary or young pod. 4.—Young pod, after the fall of the blossom, and with the shrivelled style still attached. The mildew is seen at f. I and 2 after Gray; 3 and 4 after Sturgis.

the stem causing the top to fall over from its own weight.

When the very base of the stem is attacked the injury may appear to be due to some insect. Where

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the plants are affected after the leaves are well developed these, too, will show the disease, especially on the underside along the veins which become brownish and dead. It is on the pods, however, that it becomes most characteristic and destructive, especially if the attack comes late in the season. Here it forms large dark brown sunken spots in the tissue. At the center of these pits a tiny pink mass may often be observed. These are the spores or

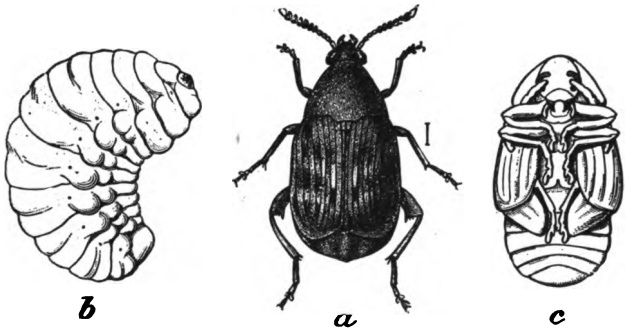

FIG. 16— BEAN WEEVIL. (*a*), THE BEETLE; (*b*), THE LARVA; (*c*), THE PUPA. SPECIMENS MUCH ENLARGED.

seed of the fungus. Where the beans are left on the vines to ripen the disease gradually works through the pod and attacks the seed, forming pits or discolored places in the bean. Diseased seed may be detected by the discolored areas on the coat and are usually imperfect, shriveled or light in weight.

The anthracnose of beans is not caused directly by weather conditions. There will be no anthracnose if the fungus is not present in the soil or in the beans themselves when they are planted, or if it is

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not carried to healthy beans from diseased plants by insects or some other means. The fungus consists entirely of tiny colorless threads in the tissue of the bean and the spores produced at the surface of the black spots. After a heavy rain or dew these spores may easily become attached to insects which visit the diseased plants and so be carried to healthy ones.

Hoeing the beans when they are wet is also sure to scatter the spores in flying drops of water. While

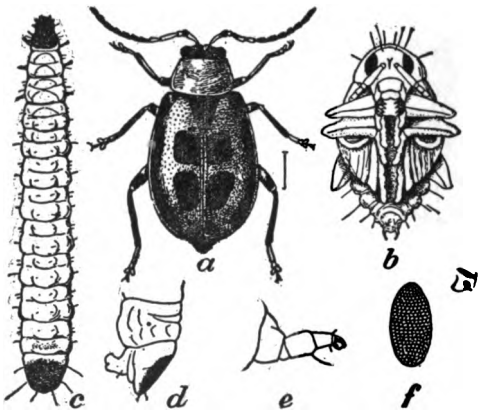

FIG. 17— BEAN LEAF BEETLE. (*a*), ADULT BEETLE; (*b*), PUPA; (*c*), LARVA; (*f*), EGGS.

the weather is not directly responsible for the disease itself, it has very much to do with the prevalence and destructiveness of anthracnose. When there is an abundance of moisture, the spore masses quickly dissolve and the spores are easily distributed by insects, rabbits, or other animals running

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through the field or by the hoe or cultivator. The spores will germinate only in moisture so that in dry weather infections would not be abundant even if the spores were distributed. Thus, it is seen that wet weather is responsible for the disease only in that it affords the conditions most favorable for its spread and development.

Treatment for anthracnose must be preventive rather than curative. The following are believed to be the best means of controlling the trouble: Plant

FIG. 18— WEEVIL-INFECTED SEED, SHOWING (*b*) AN EGG, GREATLY ENLARGED, AND (*a*) EGGS ON SEED.

clean seed. If possible obtain seed from fields known to be free from anthracnose. If seed from diseased fields must be planted, it should be carefully hand sorted and all seeds not perfect and bright should be rejected. While seed treatment has not been generally regarded as effective, some experiments at Cornell university gave profitable results. The seed which was badly diseased was soaked for 45 minutes in formalin of the strength of 1 to 200. Finally spray thoroughly with Bordeaux mixture. Use the normal strength which is 6 pounds of vitriol, 4 pounds of lime, and 50 to 60 gallons of

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water. The addition of resin soap will add to the effectiveness of the mixture by making it spread more evenly and it will be less easily washed off by rains. Resin soap can be made by mixing 2 pounds of resin and 1 pound of crystallized sal soda to 2 quarts of water. These are boiled until a clear brown solution is obtained. This solution, added to one barrel of Bordeaux, will be about the proper mixture. In the large growing centers in New York, the

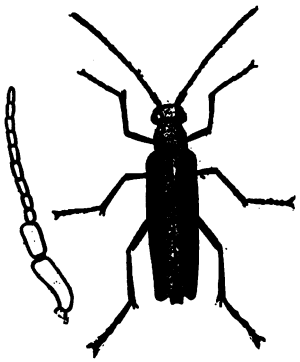

FIG. 19— ASH-GRAY BLISTER BEETLE.

growers are emphatic in pronouncing spraying an important operation in the production of beans. They also agreed that the addition of soap is important. The first application should be made about the time the third leaf is expanding or earlier if the disease appears to any considerable extent. Applications are repeated three or four times at intervals of 10 to 14 days or whenever the rains wash off the Bordeaux. Commercial bean growers seldom have

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to spray more than three times. Various stations* have done much work along this line and data can readily be obtained by addressing the directors. Fig. 14 shows a bean plant affected with anthracnose.

Bacteriosis (*Pseudomonas phaseoli*) is a bacterial disease which affects both lima and field beans. Some varieties seem to be more susceptible to it than others. It was first brought to notice by Professor Beach who found it abundant and wrote** concerning it. It develops into a serious malady about August 1, and does the most damage during the hot weather of that month. It appears upon foliage, stems and pods and is easily distinguished from any other trouble of beans. The foliage is usually the first to be attacked. On this it produces large, watery, brown patches, that shortly become dry; the tissue curls and breaks away, leaving the foliage ragged and worthless. Halsted*** says the pods are a favorite part for the bacteriosis, where it first shows itself as small water-clogged, discolored spots that spread rapidly and produce large patches, with borders tinged with pink and bearing a pale amber colored incrustation upon the most affected part. All that has been said concerning the anthracnose as to its being perpetuated and spread through the seed, holds good with bacteriosis; in fact, the two diseases may, for all practical purposes be considered as one, so far as the remedy is concerned.

Treatment.—Bacteriosis is due to a micro-organism. Spray thoroughly with the same formula and in the same way as recommended for anthracnose. So far as Halsted* could find, there is no indication

*N Y Geneva Bul 48; N J Bul 151; Del Bul 163. **Identity of Anthracnose of the bean and watermelon, 1893. ***N J Bul 151.

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that any fungicide, good for controlling bacteriosis, will not prove equally effective with anthracnose. He finds that bacteriosis is greatly favored by certain climatic conditions, in fact this much is true of all fungous diseases, and, therefore, no matter what precautions are taken, the disease may be much more abundant some seasons than others. While this in a way would discourage the grower he should double his efforts to bring on a good crop of beans by careful spraying and well directed precautionary methods.

Mildew (*Phytophthora phaseoli*), a serious enemy of lima beans, was first described by Thaxter** and later more fully considered by him. *** Halsted**** says a microscopic examination of the plant affected with downy mildew shows that it is penetrated by the slender threads of the fungus which come to the surface and there produce tufts of branching filaments and bear multitudes of spores, all of which constitute the light moldy covering, which suggests the common name of downy mildew given to many members of this family. Prof. W. C. Sturgis***** has made a careful study of the disease; his illustrations of the disease are pictured in Fig. 15.

Treatment.—Bean mildew depends largely on the amount of moisture and will be less noticeable in dry seasons than in wet. This suggests that the grower avoid putting his beans on low ground. Select fields favored with a high and dry location because in such situations the mildew will be much less certain to gain a foothold. Conclusions drawn from the experiments with fungicides show that even in a season

*N J Bul 151. **Botanical Gazette, Vol 15. ***Ct Sta Rpt, 1889. ****Ct Sta Rpt, 1897. *****N J Bul 151.

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most favorable for the lima bean mildew, a thorough treatment of the vines with Bordeaux will insure a crop. The selection of well drained land and a light soil, reducing the number of vines in the hill, and planting the poles erect will insure conditions little favorable to the development of the fungus.

Bean rust (*Uromyces appendiculatus*), an old fungous enemy of the bean, was described by Personn as early as 1797. However, it is not usually a serious trouble in this country. Halsted tells us* this disease forms small, brown, circular spots scattered

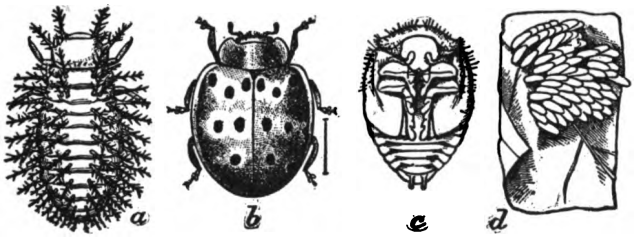

FIG. 20—BEAN LADYBIRD. (*a*), LARVA; (*b*), BEETLE; (*c*), PUPA; (*d*), EGG MASSES. ALL THREE TIMES NATURAL SIZE.

over the surface of the leaf, most abundantly upon the under side, while the leaf stalks and even the pods are likewise affected. When upon the pods, the spots are often larger and more elevated than upon the foliage. The color of the spots at first is nearly that of iron rust, from which fact the common name is derived. A large part of the destructive work is done before its presence is recognized and there is but little hope of saving foliage that is already badly rusted.

*N J Bul 151.

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Treatment.—As with all rusts the treatment must consist largely in preventing the plants from becoming attacked. This may be done first by planting strong seed and favoring the beans with such conditions as rich soil that has not been contaminated with the rust spores by previous cropping with beans. Early spraying with fungicides will help prevent the rust from getting a foothold upon the surface of the plants. However, when the rust appears in large amounts, the crop of leaves and stems should be burned as soon as possible and the growing of beans upon that land omitted for a term of years. Some varieties are less susceptible to the disease than others and it is well to select the stronger growing sorts.

Bean leaf spot (*Isariopsis griseola*), another common fungous trouble of the bean, is quite different from other diseases in that it is confined chiefly to the foliage where it produces numerous spots, usually small and angular, without any colored border. Halsted says* the fungus itself forms a gray, moldy covering upon the under surface of the spot where the spores are produced in vast numbers. He concludes that, since the spore production is of a superficial nature, the fungus is amenable to the ordinary treatment for similar diseases. Thorough spraying, therefore, with a good fungicide such as Bordeaux, is here recommended.

Bean leaf blotch (*Cercospora cruenta*) affects the foliage. It is found frequently in various sections of the United States. The fungus produces patches on the leaves which become useless and fall away. The spots have an angular appearance something similar

*N J Bul 151.

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to the bean leaf spot. The disease has, however, a tendency to checker up the leaf more than leaf spot. Repeated tests have shown that the disease can be readily overcome by thorough spraying. Therefore, any fungicide, such as Bordeaux, that is used for anthracnose may be used with equally good results against leaf blotch. It is fortunate indeed for the farmer that practically the same spraying with Bordeaux will check the advance of any or all of the fungous diseases, known as enemies of the bean plant.

Other diseases of beans are of little commercial importance in the United States. The bean canker is a disease of French and scarlet runner beans. In 1901, many reports were received by the New York experiment station relative to a disease of the bean plant. The stems of nearly grown plants were broken over at the joints and an examination revealed the appearance of rotting at the joints. The trouble came to be known as the joint rot of the bean stem. Professor Stone* tells us that the real character of the trouble and its cause were not discovered though it was supposed to be due to excessive rains. Inquiry the following season in the bean fields did not reveal its presence in spite of the fact that the season was characterized by greater abundance of rain than the preceding one.

INSECT PESTS

Bean weevil (*Bruchus obtectus*) is a formidable enemy of beans. It not only oviposits and develops in the pods in the field, but continues to breed for successive generations in harvested and stored seed,

*N Y Cornell Bul 210.

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until the seed is useless for planting or as food for man or stock. In southern sections and even as far north as Washington, D. C., it is almost impossible to obtain a crop of beans uninfested by bean weevil, and hence the stores in the southern cities are supplied mainly from the north. The bean weevil varies in size but its length will average about an eighth of an inch. The wing covers are mottled and the insect is thickly coated with fine brown, gray and olive pubescence. F. H. Chittenden* says that oviposition takes place primarily in the field, eggs being deposited upon or inserted in the pod through the hole made by the jaws of the females and other openings such as are caused by drying and splitting. In shelled beans the eggs are dropped loosely in the bag or other receptacle in which they are stored or are placed in holes made by the weevils in their exit from the seed. Less seldom they are attached to the outer surface of the seed. Unlike the pea weevil, a large number of individuals will develop in a bean, as many as 28 having been found within a single seed. Beetles begin to issue from the beans in a climate like that of the District of Columbia as early as October. The beetle is shown in Fig. 16.

Treatment.—No satisfactory preventive of the bean weevil in the field has yet been found. Attention must, therefore, be directed to destroy the insects in the dry seed. The only thing to do is to resort to fumigation or heat. The earlier the seed is treated after being gathered, the better will be the results. Just before planting, seed infested should be lightly thrown into water. The injured seed will

*U S Year Book dept agri, 1898.

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float and may then be picked out and destroyed. Sound seed only should be reserved for planting. Prof. C. M. Weed recommends* that the beans be enclosed in a tight vessel and fumigated with bisul-

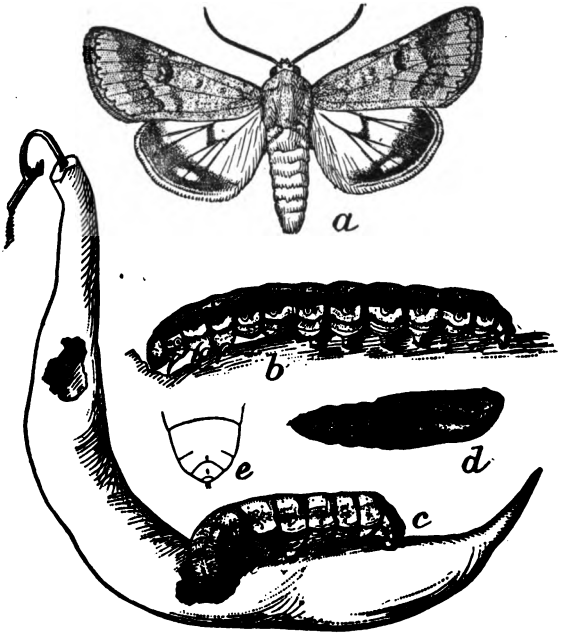

FIG. 21—BOLL WORM. (*a*), MOTH; (*b*), DARK LARVA; (*c*), LIGHTER LARVA ENTERING POD; (*d*), PUPA.

phide of carbon. The same treatment is recommended by William Saunders.** The last named authority, recommends the following manner of procedure: Use an ordinary coal oil barrel which will hold close to 5 bushels of beans. This can be treated

*N H Bul 59. **Canada Exp Farm Bul 52.

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with 3 ounces of bisulphide of carbon, which may be poured on the beans. Care must be taken to close the top tightly; the exposure should be for 48 hours. The bisulphide should be of the best quality because this will vaporize without any residue. The vapor of this substance is very inflammable and the work should, therefore, be done at a distance from other buildings and no light of any kind be brought near. For complete details of the bisulphide of carbon treatment see "Fumigation Methods" by Prof. W. G. Johnson, published by the Orange Judd Company of New York.

The four spotted bean weevil (*Bruchus quadrimaculatus*) differs from the common cowpea weevil in that the ground color is black with black, gray and white pubescence. The antennæ are serate and not pectinate in the male. Chittenden* says the species is undoubtedly exotic, but its origin and the time of its introduction are obscure. Its distribution extends throughout the South and in all probability wherever cowpeas grow. It is evidently acclimated as far north as Iowa. Fig. 18 illustrates a bean affected by this insect. The cowpea is the favorite food, the Blackeye variety seeming to be preferred. Peas and beans of various sorts are also attacked. It is advisable to keep seed in a perfectly dry atmosphere. The remedies are the same as for the common bean weevil.

Foreign bean weevils.—Chittenden says* in foreign countries there are other species of bean and pea weevils, two of which are of sufficient importance to command the attention of growers in the United States. These foreign weevils have been

*U S Year Book dept agri, 1898.

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imported into this country several times, but so far as known, none has become entirely acclimated. The same authority says he believes it quite probable their introduction will be effected sooner or later, in spite of the reported failures of such individuals as have been brought here to survive and procreate. The most important of the foreign weevils is what is familiarly known as the European bean weevil (*Bruchus rufimanus*). It is common and destructive in Europe and North Africa and although it prospers on peas as well as beans, it seems to favor the Broad or Windsor varieties. Chittenden reports that it was found in nearly every one of many samples of Windsor beans exhibited at the Columbia exhibition in 1893. During the same year the species was found in peas at the college station, Texas. Apply the same remedy as for weevil.

Mexican bean weevil (*Spermophagus pectoralis*) which breeds in the seeds of beans and cowpeas, is another foreign weevil found in large numbers in South and Central America. It occurred in great numbers at the Columbia exhibition but the infested material was fumigated or destroyed under Professor Chittenden's direction and thus its possible introduction from that source was prevented. The same treatment as for the common bean weevil is recommended.

Blister beetles.—Chittenden, in his very comprehensive description of insects injurious to beans, says that several of the many species of Meloidae, or Blister beetles, so destructive to crops particularly in the Southwest, are very injurious to beans, peas and other leguminous crops. These insects are

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gregarious; their habit in some seasons is to congregate in great numbers, when, as they feed most voraciously, they injure the crop in a few days beyond recovery. The most troublesome Blister beetle in this respect is familiarly known as the Ash Gray Blister beetle (*Macrobasis unicolor*) a female specimen of which is shown in Fig. 19. The beetle is elongate in form, has a rather soft body of uniform ash gray produced by a dense covering of minute hairs of this shade. It inhabits the entire eastern United States, over Canada, New England, and South Dakota to Florida and Texas, and often extends westward to Kansas and Nebraska. The beetles do severe injury to beans by devouring leaves. In many instances it has been found on cowpeas and Soy beans and also on potatoes, tomatoes, etc. The larvæ feed upon grasshopper eggs, a habit which renders them of very great aid in keeping these pernicious insects in check. This is especially true in western states where both Blister beetles and grasshoppers abound. However, the harm they do overbalances the good, and insecticides should be used freely when they occur in harmful numbers. Paris green is one of the best remedies for this beetle. It may be applied dry, mixed with 10 to 20 parts of plaster or air slaked lime or in the form of a spray; also mixed with lime or Bordeaux at the rate of ¼ pound of Paris green to 40 pounds diluent. Chittenden says that unfortunately in the use of an arsenite upon beans there is difficulty in obtaining a true mixture of the solution sufficiently strong for the destruction of the insects without endangering the plants by burning or scalding, though the addition of lime mitigates this to a certain ex-

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tent. Repeated applications are sometimes necessary since poisoned beetles are replaced by others.

Still another beetle which is particularly against the bean industry in the Northwest is Nuttall's Blister beetle (*Cantharis nuttalli*). The beetle is a large and beautiful insect, variable both in color and size. It is a bright, metallic green, with head and thorax usually of coppery lustre, and wing covers often purple. It varies in length from ½ to 1 inch. The insect is particularly abundant in Colorado, South Dakota, Minnesota, Montana, west Nebraska, and northwest territories of Canada. It works very rapidly and is noted for its sporadic attacks. Owing to the rapidity with which it scatters havoc among the bean fields, poisons cannot be depended upon, Chittenden says stringent measures for the beetles' destruction are necessary. They may be destroyed by three methods: (1) By driving them into windrows of dry straw and burning them; (2) by spraying into nets like those used by insect collectors and throwing the captured insects into a fire; (3) by beating beetles into safely prepared pans of water in which there is a thin scum of coal oil.

The Bean Ladybird (*Epilachna corrupta*), also frequently referred to as the spotted bean weevil, has been known for many years, but it has been found injurious only for a few. It is nearly hemispherical, in outline, broadly oval; its length is a little more than ¼ of an inch. Its color is light, yellowish brown with four black spots on each wing cover. The insect is often described as being one of the worst enemies to bean crops in the West. In both larval and adult stages it devours all parts of beans. The full grown larvæ shown in Fig. 20 is about the same length

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as the adult. The beetle where observed in New Mexico makes its appearance from the latter part of June to the middle of July; the new brood is to be found in September and October. The winter is passed in adult stage and only a single generation has been observed in a year. Paris green is one of the most useful insecticides for the destruction of this species. However, great care must be taken in its application since certain varieties of beans are likely to be killed by the burning of the leaves. It should be applied as an underspray at the first appearance of the beetles. Kerosene emulsion applied as an underspray gives still better results. Hand picking of the beetles and their eggs at their first appearance is a preventive measure practical only where grown in small quantities.

The Bean Leaf beetle (*Cerotoma trifurcata*) is an insect of considerable importance in the gulf states and of less consequence in parts of Maryland and Virginia, (Fig. 17). The adult beetle eats large, round holes in growing leaves of beans and cowpeas. It measures from 1-7 to 1-5 of an inch in length and is nearly twice as long as wide. It varies greatly in color from pale yellowish or buff to dull greasy red, with black markings. Sluggishness of the beetles makes hand picking possible in small gardens early in the season. Pyrethrum is said to be useful in checking the depredations; however, in a commercial way spraying with one of the arsenicals should be resorted to. The remedy should be applied on the first appearance of the insects in order to stop them at the outset. Chittenden mentions other injurious beetles such as the banded flea-beetle (*Systena taeniata*); the pale striped flea-beetle (*Systena blanda*)

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and the twelve-spotted cucumber-beetle (*Diabrotica 12-punctata*). These all have been found doing damage on beans. However, the bean plants may be protected largely by a dusting of air slaked lime. In the case of garden beans and in a commercial way, Bordeaux to which has been added poison will prove effectual.

Corn Ear worm (*Heliothis armiger*), often known as the boll worm will not infrequently bore holes into pods and seeds of maturing beans. It is a species of wide distribution and destructiveness. Fig. 21 gives an idea of this creature in its relation to the bean plant. Poisons cannot always be depended upon for a remedy as applied in form of spray. Thorough applications of Paris green, either in the form of a spray or dry powder will doubtless kill the young caterpillars. Late fall plowing is of great value in ridding infested fields of the worms. These are best combated, however, by bait composed of bunches of clover grass or weeds poisoned by dipping into a solution of arsenic or Paris green. A mash of bran poisoned in a similar manner and scattered around the bases of the vines is also effectual. The salt marsh caterpillar is sometimes injurious to beans. It is amenable to the use of arsenites.

Bean Leafrollers (*Eudamus proteus*), a caterpillar often called roller-worm which has proved very destructive in Florida, is ordinarily injurious to leguminous plants particularly beans in the gulf states. It is the larva of a butterfly called the swallow tail skipper. The ground color of the larva is yellowish, its head dark and marked with two orange spots near the mandibles. The head is prominent and separated from the body by the narrow neck, a characteristic which serves to distinguish it from any other common

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caterpillar on garden crops. Paris green is recommended in the proportion of 1 pound to 50 gallons of water to which may be added 1 pound quick lime. This insecticide does not destroy the foliage of the plant.

Other insects.—Several species of bean lice, bugs, leaf hoppers, etc., injure the vitality of bean plants by sucking their juices. The most abundant forms of the plant lice have been *Aphis gossypii,* and *A. rumicis.* The leaf hopper most injurious to beans is *Empoasca fabae.* In the plant-bug kingdom the enemies most injurious are *Halticus uhleri.* The standard remedy for this class of insects is kerosene emulsion and since they feed largely on the underside of the leaves underspraying is essential.

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CHAPTER VIII

CULTURAL METHODS

Early plowing.—Two vital points in the success or failure of the bean crop are the preparation of the seed bed and the planting of the seed at the proper time. It is safe to say there is no single thing responsible for more partial failures in bean growing than the late and hasty preparaton of the land. The rush of spring work in getting in oats, corn, potatoes, etc., too often delays the plowing of bean ground until the very last of May or often early in June. The best results cannot be obtained unless the bean ground is plowed early. In New England the first week in April is none too soon. Then the soil should be stirred with the cultivator or dragged every week until time for planting. This early preparation serves a double purpose. It kills hundreds of germinating weed seed, thus greatly lessening the amount of cultivation afterwards required and what is still more important, it conserves the soil moisture. The repeated stirrings store up moisture for the use of the plant later in the season when the crop is greatly in need of it. Extra time in the early preparation of the soil will be justified in the greatly increased yield at harvest. A gain will be especially marked in case of a drouth to which many sections are subject. On this point, Professor Stone of New York, says*: "More frequently than otherwise the crop suffers from lack of moisture at some time during the season, and the early plowing and early feeding is the best means of

*Cornell University, Bul 210.

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guarding against this contingency. Deep plowing, not less than 6 inches, is recommended. Some farmers plow the fall before, but this is the exception rather than the rule. Inverted clover sod is ideal for beans. A common rotation in large bean growing sections is clover, beans, wheat.

Time of planting varies with locality, season and the variety of beans used. Here the best judgment is

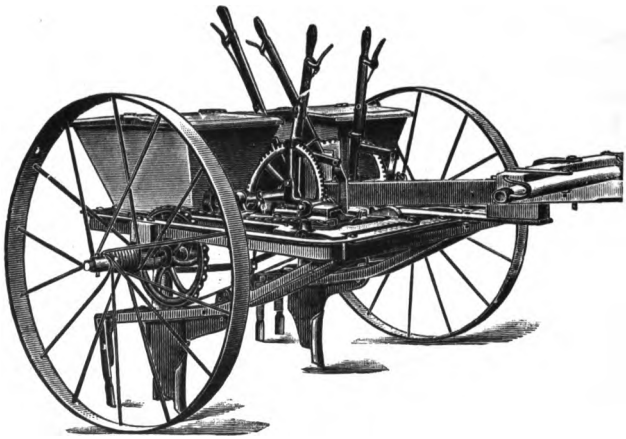

FIG. 22— A STANDARD BEAN PLANTER.

required. The aim should be to have beans start promptly after planting, and keep growing until they reach maturity, suffering no setbacks. As a rule do not be in too much of a hurry to plant. If beans are put in cold ground, many will rot and others lose their vitality. Some of the strongest will come up, and their neighbors if they come up at all, will be two or three weeks late. This results in uneven ripening, one of the things to be avoided by bean growers.

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Even if the beans do finally germinate and come up, they will manifest a reluctant growth through the season, much like the stunted animal. There is still another reason why beans should not be planted too early. They are very tender plants, and a slight frost will level them to the ground. If one will wait until the soil is warm the majority of these difficulties will be avoided. While visiting one of the largest growers in New York I was told the time to plant is June 5. "Plant then," said my host, "and nature will always be with you." This grower lives in latitude 42 degrees, 30 minutes north; his soil is a rich, black loam. He never fails to obtain a large and favorable crop. Prof. J. L. Stone,* recommends that the kidney and Black Turtle Soup varieties be planted during the last half of May. According to the same authority, the pea varieties should be planted June 5 to June 20, while the marrows and yellow eyes come intermediately. In the latitude of 43 degrees in Michigan the small navy beans are planted about June 10 with excellent results.

Hills or rows.—In general, results favor planting beans in drills rather than hills. Prof. L. C. Corbett** planted 2 pounds of seed in drills and harvested 140 pounds of beans. The same quantity of seed was planted in hills and but 50 pounds were obtained at harvest. In experiments at the South Dakota station*** tests on both a small and a commercial scale were made of planting beans in hills and sowing in drills. Planting in drills gave best results in both cases and this method is recommended.

*N Y Cornell Sta, Bul 210. **W Va Sta, Bul 49, pp 467-507. ***Bul 47, pp 42-46.

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Amount of seed to use.—The distance apart of drills varies from 24 to 36 inches but the usual distance is 28 inches. Prof. A. M. Ten Eyck* reports that beans drilled in rows 2 feet apart gave a larger yield and earlier crop than when drills were made 3 feet apart. Experiments by Doctor Halsted** in planting beans at distances of 3, 4½, 6, 9, 12, 18

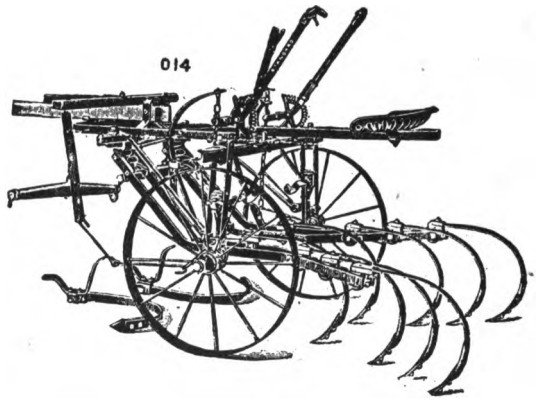

FIG. 23— CULTIVATOR OFTEN USED FOR BEANS.

and 24 inches in rows 20 inches apart resulted in favor of 4½ inches apart in the row for best yield. This was with the Golden Wax variety. A significant fact which should not be lost sight of in his experiment is that the number of spotted pods decreased as the distance between the plants increased. This would indicate that bean plants cannot be crowded without inviting fungous diseases. On the

*N D Rpt for 1900, pp 98-101. **N J Rpt, 1895, p 290.

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subject of thick or thin planting the Kentucky experiment station found* Improved Valentines and Golden Wax varieties gave largest yields when 1½ ounces seed were used to every 12 feet in the row. The report indicates, however, that in order to provide against some of the seeds not germinating, it is better as a rule to use a slightly larger proportion of seed. Professor Jordan** after trying out 72 varieties and plantings of 1 quart seed to 810, 405, 270, 203 and 162 feet of drill, concludes that 1 quart of seed in 162 feet gave the best results. There was a tendency in the thicker planting towards smaller pods. The vines were more spindling and development was more or less reduced.

So far as the commercial grower is concerned it seems to me Professor Stone sums up the whole matter very well when he says, "The amount of seed required to the acre varies with the variety. Of the small beans (marrow and Boston small pea) many growers plant ½ bushel to the acre, though some claim better results with 3 pecks or even 1 bushel. Five or even 6 pecks to the acre of kidney beans are recommended and intermediate amounts of the other varieties according to size. It is evident that with seed of strong germinating power and soil in fine condition, a smaller amount of seed is required to procure the proper stand than in the case of poorer seed and less favorable conditions. The grower must bear in mind that beans are gross feeders and when 1½ to 1¾ bushels are planted to the acre, the plants consume the fertilizer readily available, before the pods are fully set and there is, therefore, little feed left for the maturing seed.

*Bul 54. **N J Sta Rpt, 1898.

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Depth to plant.—Comparatively shallow plantings will give best results. Halsted* in several experiments finds that planting at various depths of 1 to 5 inches showed little difference between the shallower plantings. Those planted 5 inches did not grow. A depth of 1 to 2 inches is here recommended.

Method of planting.—On a commercial scale beans are usually planted with a horse planter, or an ordinary grain drill. In cases of the latter, enough of

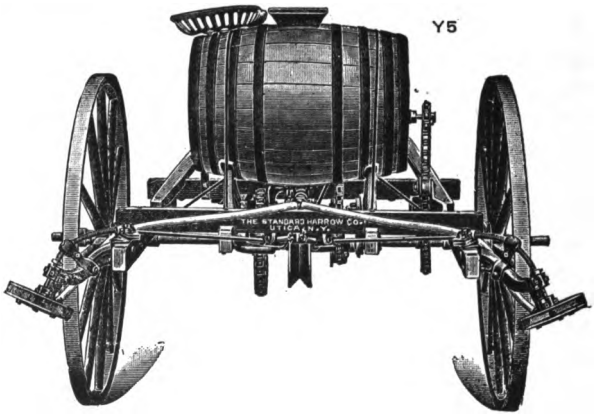

FIG. 24—SPRAYER USED IN BEAN FIELD.

the tubes are closed to make the rows the proper distance apart. The grain drill is used extensively in bean growing sections of New York and parts of Michigan. Where the larger varieties of beans are grown, the special bean planter is particularly preferred, as it handles the seed much more satisfactorily than the grain drill. The regular bean planters, a

*N J Rpt, 1896, pp 330-333; also p 382, Rpt 1899.

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number of which are on the market, do excellent work. Some growers prefer a planter having the slide rather than the disc to regulate the dropping of the beans, claiming that the slide cracks less beans. Another point which some growers emphasize is having the rows run north and south, for the same reason that open shocks of wheat are set two by two north and south. The theory is that the sun can get into the rows and on both sides of the plants as it does in the case of the long shock set north and south. On a comparatively small scale beans may be planted successfully by hand; either with the hoe, or better still by means of the hand corn planter. In this event, a marker is usually run over the piece before planting to serve as a guide for the rows. The hand planting process is much more laborious and is not the twentieth century way of planting beans on a commercial scale. Fig. 22 shows commercial bean planter.

Cultivation.—If the seed bed has been properly prepared the operation of keeping the beans clean will be a simple one and less cultivation will be required to conserve soil moisture. C. L. Allen, the successful Long Island horticulturist, gives it as his opinion* that the usual method of cultivating beans is wrong. He takes the position that beans should be cultivated before the bean is planted; that is, put the extra work, in stirring the soil, into the preparation of the seed bed. Having done this, he advises the farmer to stay out of his bean field with the cultivator, after planting, unless a crust on the soil forms. This it is necessary to break. Mr. Allen considers the success of the crop depends considerably in keeping away from the roots of the plants.

*American Agriculturist, May 2, 1903.

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FIG. 25—PICKING SOUTHERN BEANS FOR NORTHERN MARKETS.

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I am not ready to say that cultivation of beans is not advisable, nor does the work of the experiment stations, to date, justify any such a conclusion. However, I am certain that farmers as a rule cultivate their beans too deeply. Thrifty, growing plants will soon send their roots into the center of 20-inch rows to meet those of the neighboring plants. To run the cultivator through these roots, tearing and breaking them off on either side of the row is not as nature intended. The shovel plow, to dig up weeds and foul growth will not be necessary if beans have been planted as they should be. It is my experience that beans should not be cultivated nor in any way disturbed when the foliage is damp from dew or rain. The work of the experiment stations also indicates the same conclusion. Soiling of the leaves and stems seems to promote the development of disease. The orthodox way of cultivating beans does not differ greatly from that followed with corn.

Whether to cultivate while beans are in blossom is a very interesting question which no one seems to have solved to the entire satisfaction of all interested in growing the crop. The experiment stations are surprisingly silent on this question. There are hundreds of farmers who would not think of cultivating beans when in blossom, and perhaps equally as many others who go ahead and stir the ground whenever it seems to need it. If cultivation is given it must be shallow, because at this stage of the crop, the lateral roots are so far developed that stirring of the soil to any depth will cut off many of the feeding roots. My father always considered the admonition to keep out of the beans when in blossom in the same class with those theories that advise planting of potatoes and

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other crops in the new or the full moon. His pet expression was, "I would rather have my potatoes in well prepared ground, than in the new or full moon." He cultivated his beans when they were in blossom and the crop apparently suffered nothing thereby. Obviously, conditions of the crop, weather, season, etc., would make considerable difference and might easily determine which method should be followed.

The implements ordinarily used in cultivating are a two horse cultivator or a walking cultivator. There are numerous makes and varieties of these on the market. The wheel cultivator provided with guards to protect the small bean plants from dirt thrown out by the teeth of the machine is most generally used in large growing centers. This will cultivate two rows at a time, and considerable ground may be gone over in a day. Weeders or light drags cannot be used to good advantage if the crop is up, as the bean plants are so tender. I am advised, however, that some bean growers use the weeder when the plants are far enough along to have formed several leaves, and the stems have become toughened.

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CHAPTER IX

HARVESTING THE CROP

Time of harvesting.—Ordinarily beans are ready for harvesting the latter part of August. However, the season, time of planting, variety of seed and condition and care of soil are modifying agents. It is desirable to have the crop ripen evenly, which will usually be the case provided the soil and methods of culture are uniform. Some growers harvest early, when the pods reach the wilting stage, others advise waiting until the plants are dead ripe when the process of curing will be much simplified. In my experience and observation the best time to harvest will depend very much on the season and as in many other things, each grower must use his own judgment, and weigh evidence carefully as it presents itself each year. Obviously it would be poor policy to start the bean puller during a week of rain, even though the beans were ripe, and on the other hand, fine curing weather for the crop might justify pulling a few days earlier than would otherwise be advisable. All other conditions being equal, allow the crop to gain full maturity.

Methods of pulling.—In no branch of agriculture have twentieth century methods been attended with a more marked revolution than in harvesting the bean crop. Instead of the old back breaking process of pulling every hill of beans by hand, we now have improved horse pullers which gather two rows of beans as fast as a good team of horses will walk.

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Men follow with pitchforks to fork the plants from the earth and throw two or three rows, as left by the puller into windrows or small piles, according to the fancy of the farmer, in which conditions they are allowed to dry out well. This is a much easier, simpler and more rapid way of gathering the crop, besides it removes one of the most disagreeable and tedious operations of the farm. Well do I remember those early days, on my father's farm in Michigan, when I used to creep along on my knees in the bean

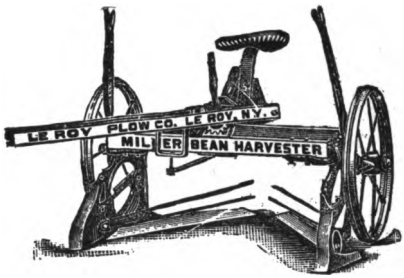

FIG. 26—A BEAN HARVESTER.

field in a vain attempt to relieve the jumping toothache in my back, an ache that always attends a steady day's work pulling beans by hand, no matter whether the laborer be old or young.

In small fields, hand pulling may be advisable, even now, but a good machine such as pictured in Fig. 26 also Fig. 3, is indispensable to a man growing beans for commercial purposes. It consists of the frame, mounted on two wheels which resemble those on a horse cultivator; in fact, there is in use on many farms a combination cultivator and bean puller. When it is desired to change the cultivator

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to a bean puller, the teeth are removed, and the two knives substituted. Some farmers recommend this combination very highly. The bean puller is provided with two shares or knives, which are set obliquely, so the front of each knife will run just outside the row of beans, and the rear of the knife will extend into the center of the row. The two knives set to run just below the surface of the soil will thus cut off the roots of the plant and draw two growing rows of beans into one pulled row, as shown in Fig. 3. The iron guard rods above the shoes are provided to aid in collecting vines and freeing them from earth. The next operation is for men to follow with ordinary forks and shake the vines free of soil, which would color the beans, in case of storm, if left half buried in the ground. It usually requires five to six men with forks, to keep up with the puller and a good team of horses. The men also pull out any stalks which by reason of stones, extremely hard soil or long surface roots were missed by the puller.

While in the large growing centers of Michigan recently I learned another alleged improvement in the operation of harvesting beans. A side delivery hay rake was used with considerable success to follow the bean puller and get the vines out of the earth. This, of course, dispensed with the services of the men with forks. There are objections to this method, but it means a great saving in labor. The illustration (Fig. 27) shows a little girl manipulating one of these side delivery rakes in a bean field. The rake separates two rows as left by the puller, takes them out of the ground, and lays them over on clean land. Each bout throws four rows as left by the

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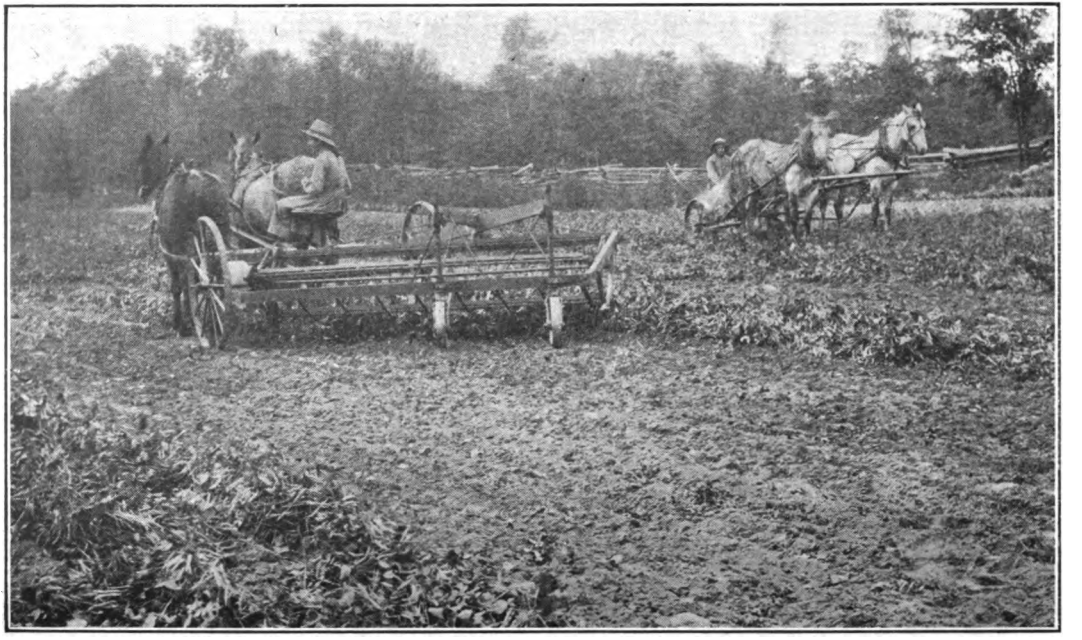

FIG. 27—SEPARATING BEANS FROM EARTH WITH SIDE DELIVERY RAKE.

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puller, together, where the vines remain to dry. Estimating that five men can pull and pile one acre of beans in a day, the boy and girl pictured, in pulling with the machine and raking out of the dirt with the side delivery rake, equaled the combined efforts of 40 men. This, since they handle 8 acres in a day which is the average work for one of these machines.

Farmers who use side delivery rakes for gathering the bean crop, almost invariably go a step further and use a hay loader in getting the beans on to the wagon at hauling time. The frontispiece of this book gives an idea of the manner in which this work is done. As in drawing hay, the loader is attached to the rear of the wagon and the team driven astride the rows of vines left by side delivery rake. The load can be taken on as rapidly as a team of horses will walk. One man on the road can place the vines with little tramping around, and if the team does not follow the row, a boy for teamster comes in good play. While the rank and file of bean growers in large growing districts have not adopted the side delivery rake and the hay loader, it is being seriously considered by increasing numbers. They recognize the importance of labor saving devices in this day of high priced labor and the unsolved problem of satisfactory farm help. I have seen an ordinary horse rake used for getting the beans, as left by the puller, out of the dirt, but I must say it has always appeared to me a very unsatisfactory and expensive manner of performing this operation. Farmers who have tried the standard horse rake and the side delivery rake, speak decidedly in favor of them.

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The drying process is found a source of much trouble in case of heavy vines pulled before fully ripe or if the weather is cloudy and rainy. The white varieties of beans color very easily and as this means a second or third grade product, the vines should be turned frequently in case they are caught out in inclement weather. Bean growers all know that it is disastrous to leave vines in rows as left by the puller, and not shaken free of the earth, through a rain. If the weather is fair all will be well and vines whether thrown in piles or rows will soon be ready for hauling. In case of the modest grower who has but a small garden-patch, the beans are often put up in stacks about as high as one's head. A false foundation 3 to 5 feet in diameter, of short sticks of wood or other material, is made, a pole set in the center and the beans piled around this, with roots pointing toward the pole. Thus handled the beans will stand ordinary weather for weeks with little ill effects. Beans are rarely broadcasted, but if they are, about the only way to harvest them is to mow and handle as the pea crop would be. Professor Stone suggests that an ingenious man could adapt a shoe or knife to run ahead of the regular bean puller, and do the work satisfactorily. Few farmers, however, will have broadcasted beans as it is not considered advisable to sow the crop in this manner.

Hauling the crop.—The methods of hauling are simple and vary but little in different sections. The orthodox way is for two men, one on either side of the wagon suitably provided with an ordinary hay rack, to pitch on the beans and shape the load from the ground. The wagon is driven between the rows

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or piles of beans as left by the men who shake the vines free from earth, or as left by the side delivery rake. Some growers advise getting on to the load and tramping the vines down, so more can be gotten on the wagon at a single load. However, the practice recommended is for all the loading to be done from the ground as in this way fewer beans are shelled. Farmers who use hay slings on the wagon as in drawing hay, and mow the beans away in the barn by means of horse power cannot easily avoid getting on the loads to arrange the slings. It is never advisable to put beans into the barn when wet, or not thoroughly cured. Some farmers have learned to their sorrow that the harvesting process cannot be rushed in this way, and that premature drawing means a practical loss of the crop as the beans will heat and color on the slightest provocation.

When the hay loader is used in the bean field, it is also impossible to avoid the presence of a man on the load, but a careful worker can do what little moving around is necessary and shell comparatively few of the beans. The necessity of a man on the load is one of the principal points against the hay loader. When hauling the small stacks as put up by the grower who has but very few beans, the wagon is driven along side the stack and the entire shock lifted on the wagon. Unless the hay slings are used a man almost always gets on the load to pitch off the beans. This is a point in favor of the slings. They are easily arranged and about three drafts are made to the load and sometimes only two. As the first pair is placed on the bare wagon rack it is necessary that the man climb on the wagon only

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twice. If but two drafts were made to the load it would mean but a single climb on the wagon during the loading process. Slings may be used either when beans are loaded in the usual way by men from each side of the wagon or when the hay loader is used. In this connection it is well to say that in handling beans the slings and hay loaders are the exception rather than the rule; each grower decides for his own conditions.

Storing the crop.—If not thrashed direct from the field, beans may be stored in the barn or stacked outside. Storing beans in barns, in mows or on overlays is the most common way, and the practice is here recommended. However, in case the capacity of the barn will not admit, the crop may be stacked with comparatively little loss of beans, owing to inclement weather which may prevail. If the grower stacks his beans he must make a good job of it. False bottoms of rails or other substantial material should be made to keep the beans from the ground. Round stacks are objectionable and are but seldom made. Rather, make the stacks long and narrow. The sides are built straight up, and a good covering of second grade hay, or swale grass, is used to top out the stacks. On the old homestead in Michigan we always aimed to have room in the barn for the bean crop. Oats, corn and even hay were stacked outside to make room for the beans which were not thrashed as a rule until well into the winter. On the other hand, one of our neighbors who had a sizable crop of 40 acres annually, always stacked his beans with excellent results. From experience and wide observation I would say, put the beans inside if possible, but do not hesitate to stack outside, provided you make a good job of it.

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Thrashing.—There are at least three distinct ways of thrashing beans. All of these are more or less practiced. While there are many mechanical devices and schemes for the operation, the work will readily come within the scope of thrashing by hand, by live stock, or by special machinery. The old way was to pound out with a flail. Relics of this method are to be found to-day in many barns throughout the country. There are, too, farmers raising a number of bushels annually who still use a flail in thrashing their crop, claiming that the saving in uncracked beans more than makes up for the extra time consumed. They also argue that the work is done any time through the winter when there is little else a farmer can do. The operation is a simple one. I thumped my head more than once when a boy, trying to get the right swing. Somehow the staff and the swipel would get tangled up when they were raised above my head. One soon learns the knack, however, and a whole volume on telling how to get this proper swing would not be worth as much as 15 minutes actual experience. When thrashing with a flail, a thick layer of beans is usually put on the barn floor. After being flailed thoroughly, the beans are turned over. One turning is usually sufficient. This can be determined by examining pods which are forked off the floor and another layer put on, and the operation repeated. Finally, the beans are run through a fanning mill and the job is completed. On a small scale, blankets or canvas may be used instead of the barn floor.

Another method of thrashing which at least has the advantage of requiring less manual labor is to use live stock, like horses, to tramp out the beans. The layers of beans are made the same as though

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a flail were to be used, and the beans are turned as before. The fanning mill is also called into play to remove earth, leaves, etc, from beans. When either one of these two methods is pursued, a smaller percentage of cracked beans will usually result than when run through bean hullers.

The third and modern way of thrashing beans is the use of the machine or bean huller. This is constructed much as the grain separator; in fact, the ordinary grain separators are used in some cases by changing the concaves slightly. With a good machine 1,000 bushels of beans is not an exceptionally large day's work. The cost of the machine prohibits the owning of one by every bean grower. There is usually one in a neighborhood, sometimes two. The owners make a business of thrashing out beans for the farmers, charging as a rule, 5 cents a bushel. The power for running the machine is steam or gasoline. Some bean growers have a complete thrashing rig of their own, and thus can thrash their beans whenever they wish. This is not always the case when the thrasher man, who has a dozen or more other jobs ahead, must be depended upon. The advisability of using bean thrashers in commercial bean growing districts is not questioned, for while it is admitted more beans are cracked than when the flail is used, the element of labor saved more than compensates. The concaves in the machine may be so adjusted as to reduce the number of cracked beans to the minimum, but in such adjustment there is a possibility of getting them so far apart that the beans will not be thoroughly thrashed and seeds will be carried through the machine to the straw pile.

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As illustrated in Fig. 29, beans are frequently thrashed direct from the field. The machine is set at some convenient place in the lot and the beans hauled to it. Two teams or two wagons and one team will at least be required to keep the machine at its full capacity. The number will depend somewhat on the distance of hauling, conditions of beans for thrashing and help employed. If nothing better than "kid help" or so-called "soldier help," is available, three crews at least will be necessary, one to keep company with the other, and the third to do the work. The loaded wagon is driven along side the machine and while being unloaded another one is being loaded in the field to take its place. Two men will table the beans from the wagon to the machine, another man will feed the beans into the cylinder, two or three more will handle the beans, straw, etc. The beans are usually sacked in two-bushel bags and hauled to market or storage. By thrashing in the field, less handling is required, but as a rule, they are not thrashed out as well, though this depends largely on the weather, and the condition of the beans. Then, too, the beans have not gone through the sweat and must be watched closely in storage, and not too many put in one pile for fear of heating. Beans will thrash out much better in cold weather, and for this reason, it is often better to have them stored in the barn until the weather and other farm work make it most favorable for the thrashing operation. Whether operated in the field or the barn, the details of running the machine vary but little. Feed the beans, pods and all, into the cylinder and the machine will separate them, delivering the clean beans at one place and the refuse at another.

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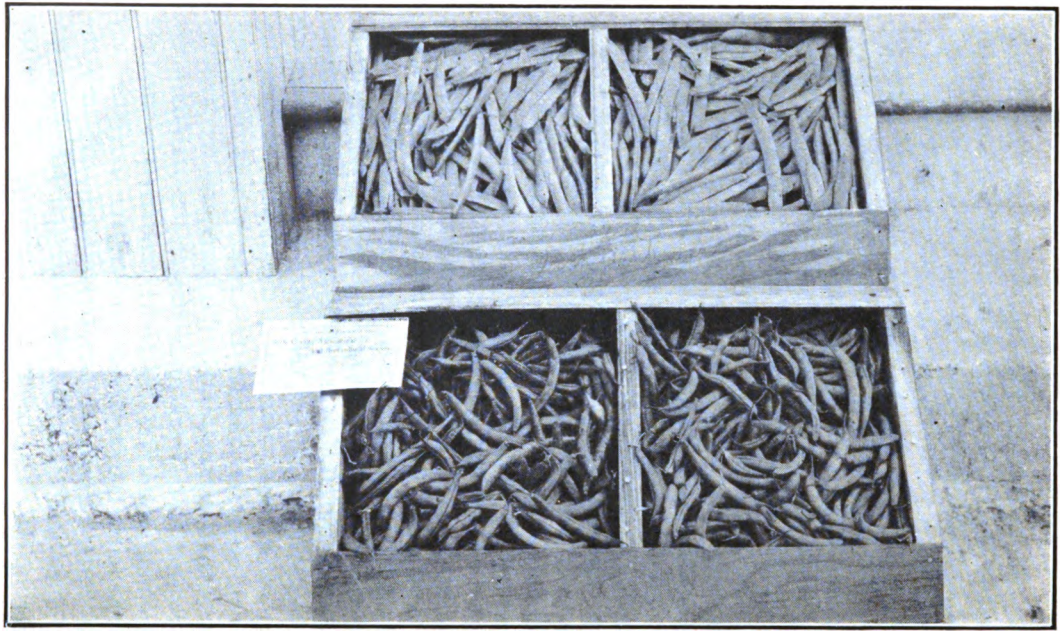

FIG. 28—FLORIDA STRING BEANS READY FOR MARKET.

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CHAPTER X

COMPOSITION AND FEEDING VALUE.

Protein content.—The bean plant is exceedingly rich in protein, that most valuable and expensive constituent of stock feeds. A sample of beans grown in New Haven county, Ct., and sent to the experiment station analyzed* as follows: Nitrogen 3.75 per cent; phosphoric acid 0.9 per cent; potash 1.4 per cent. The yield of the bean field in question was 25 bushels to the acre, and it is figured that the crop appropriated an equivalent of 56.2 pounds of nitrogen to the acre, 13.5 pounds of phosphoric acid and 22 pounds of potash. Peas grown on the same farm, the same year, took about the same amounts of phosphoric acid from the soil, as did the beans, but the last named appropriated approximately 9 pounds more each of nitrogen and potash. Damaged beans, which are sorted out by farmers or bean houses, are frequently referred to as cull beans, and form an excellent food for live stock, particularly sheep and pigs. The greatest drawback to them for horses and cattle is the small gravel stones usually more or less numerous in this grade. Sheep, however, will sort out the beans, leaving the gravel. Cull beans may be cooked and fed to swine with excellent results. If water is stirred in while they are cooking, the gravel will settle to the bottom. They are often ground and mixed with other grain and fed with excellent results to cattle. While cull

*Ct Exper Sta Rpt, 1896, p 334.

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beans have a very high feeding value, higher than farmers usually appreciate, the mistake should not be made of feeding them alone. The pure bean ration not only lessens the food value, but also endangers the health of the animals. Balance the ration with starchy feeds such as corn. The accompanying table* shows the comparative composition of cull beans, oats, gluten feed and corn.

COMPOSITION OF BEANS, OATS AND CORN

Feeds	Water	Protein	Fiber	Nitrogen free extract	Fat	Ash	Refuse mostly gravel
	%	%	%	%	%	%	%
Cull beans..	10.00	21.60	3.70	47.50	1.20	3.20	12.80
Oats	11.00	11.80	9.50	59.70	5.00	3.00	
Gluten feed..	7.80	24.00	5.30	51.20	10.60	1.10	
Corn	10.60	10.30	2.20	70.40	5.00	1.50	

A study of this table shows that cull beans contain nearly twice as much protein as oats and more than double the amount found in corn. While gluten feed has 24 per cent protein, cull beans come up to 21.6 per cent, notwithstanding the fact that 12.8 per cent was refuse, mostly gravel.

Another interesting table of analyses of fodders and feeds is that of the New Jersey experiment station,** which follows:

ANALYSES OF BEANS AND FODDER IN %.

Feeds	Water	Ether extract	Fiber	Protein	Ash	Nitrogen free extract	Albuminoids	Nitrogen	P_2O_5	Potash
Navy beans....	10.9	1.52	3.88	23.24	5.74	54.77	21.03	3.72	.94	1.45
Cottonseed meal	10.49	6.49	17.82	24.63	5.21	35.36	23.8	3.94	1.83	1.61
Crimson clover..	83.58	.48	4.34	3.16	1.31	7.13	2.09	.51	.16	.31
Hominy meal....	8.07	9.97	4.94	11.06	3.26	62.70	10.33	1.77	1.53	.84

*G. W. Cavanaugh, N Y, Cornell Bul 210. **21st Annual Rpt, 1900.

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In 1898, N. Zunitz and O. Hogenman published* their deductions from experiments made to determine the true feeding value of several feeds and fodders including beans. These figures gained from experiments with horses follow:

TRUE FOOD VALUE OF BEANS

Material	Dry matter, per cent	Labor expended in chewing and digestion. In terms of energy-calories	True nutrition value in terms of energy-calories
Beans, field	86	439	2412
Alfalfa hay, cut at beginning of bloom	84	866	928
Red clover	84	944	667
Medium hay, average quantity	85	828	721
Winter wheat straw	86	1177	460
Oats, medium quality	87	492	1943
Maize	87	325	2784
Linseed cake	88	495	2239
Potatoes	25	107	787
Carrots	15	82	365

Value of bean straw.—Bean straw is an excellent food for sheep. I have known horses and cows to be nearly as desirous to eat the pods. Never let any of the bean fodder go to waste but deal it out religiously to horses, sheep and cattle alike. It has a high feeding value as will be seen by the accompanying table showing the digestible nutrients in bean straw as compiled from recent analyses by Prof. G. W. Cavanaugh.

COMPARATIVE VALUE OF FODDERS IN %

Feed	Total dry matter	Pounds of digestible nutrients Protein	Carbohydrates (fat x 2¼)	Total
Bean straw	95.	3.60	39.70	43.3
Timothy hay	87.	2.80	46.50	49.3
Corn stover	60.	1.70	34.00	35.7
Oat straw	91.	1.20	40.40	41.6

*Landw Jahrb 27, 1898, No 3, p 440

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Remarking on this table Professor Stone* says it will be observed that bean straw contains three times as much protein as oat straw; three times as much as corn and one-third more than timothy hay. As regards the carbohydrates and the total digestible nutrients it is only slightly inferior to timothy hay. Bean straw when fed directly has a tendency to produce looseness of the bowels. For this reason it should not be made the exclusive diet, but fed in connection with foods that will correct this tendency.

Value for live stock.—Prof. C. S. Plumb publishes** some interesting facts on waste beans as a stock food. He says: "According to the experience of a number of farmers in Michigan, waste beans not suitable for market are a satisfactory feeding stuff for farm animals. The opinion is generally held by local breeder. that beans cannot be given to all classes of stock. A mixture of corn, oats, and ground beans in the relation of 2.1 respectively, give good results with horses, cattle, sheep and pigs. The beans are fed cooked to pigs, but to other classes of stock dry, ground or unground, as the feeder sees fit. They are usually ground for cattle. When fed with care, both the beans and the fodder will give excellent results, though the feeder must remember that it is a laxative food.

Barring cull beans, the common sorts of field and garden beans are seldom fed milch cows in this country. In Scotland, horse beans were found to make a good quality of butter. In Massachusetts, soy bean meal made more and richer milk and butter of better color than cottonseed meal. However,

*N Y, Cornell Bul 210. **Breeder's Gazette, p 669, 1903.

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the cottonseed meal was firmer but of inferior texture. While horse beans of many varieties have been fed and several experiments conducted to determine the exact feeding value, Lavalard finds that beans may be substituted for oats in the rations of all classes of horses, and that horses fed on beans show greater endurance than those that receive oats. Beans are recommended for stallions in service and for hard working horses. He recommends that they be fed in about half quantity of the oat ration and straw, and other coarse fodder added. The beans were fed cracked. In substituting beans in the ration ½ pound equals approximately 1 pound of oats. The same authority cautions farmers against feeding beans to horses less than one year old. For steers beans have been partially tested as to feeding values, although they are fed to a considerable extent.

Beans as human food.—Professor Snyder has published* some comprehensive experiments on the value of beans as human food. The experiments of digestibility and nutritive value of beans were made with healthy men, and the greatest degree of digestibility was secured when the beans were eaten in a mixed ration. When the skins were removed by parboiling, the beans were more readily acted upon by the digestive solvents, as pepsin, diastase and pancreatin. In 12 hours 25 per cent more of the protein nutrient was digested when the skins of the beans were removed than when the beans were baked in a similar way without removal of the skins.

*Minn Sta, Bul 74; also Farmers' Bul 169, U S dept of agri.

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When the skins of beans were removed there was less tendency for the formation of gas in the intestines during digestion. The germ and skin are the parts most fermentable and produce sulphuretted gaseous products during digestion. Not more than 6 ounces of baked beans should be consumed in a day. Beans are rather slowly digested, but 90 per cent of the dry matter in the beans was digested and utilized by the body in the experiments in question. The nutrients differ in character from the same class of nutrients in cereal foods. The protein is mainly in the form of legumin. The other extract is small in amount, but has practically the same heat producing power as in other foods. Discussing the cost of beans as compared with other foods and their importance in the diet, Professor Snyder concludes that beans at ordinary prices are among the cheapest foods for supplying protein. A pound of beans costing 5 cents contains about 1-5 pound of digestible protein and somewhat less than 3-5 pound of digestive carbohydrates, mainly in the form of starch. Professor Snyder's experiments show that beans are suitable for persons engaged in active outdoor work, rather than for those of sedentary habits of life, though if well cooked, they may be safely eaten in small quantities by those who are not actively engaged in manual labor. While the amount of protein is large, beans contain only a small amount of fat and hence the addition of fat, either by salt pork or butter, in preparing for the table is reasonable, since in addition to improving the flavor, it makes a better balanced article of diet.

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CHAPTER XI

MARKETS AND MARKETING

So popular are beans as an article of diet it is not surprising that the large area given over to this crop shows some increase from year to year. The surprise, if any, rests in the fact that while beans can be readily grown and matured in all northern latitudes, the annual yield is insufficient for home consumption and large quantities are imported. The domestic crop of beans is 5,000,000 to 7,000,000 bushels annually. In this connection it should be emphasized that in treating of the commercial crop movement and market no reference is made to green beans; i. e., the succulent product consumed in its unripe state, immature bean and pod together. Classed under the general head of dry field beans are included pea beans, navy beans, marrow, red kidney, yellow eye, etc.

The geographical distribution of the bean crop is notable. The bulk of all the beans is grown in three states, Michigan, New York and California. Areas of lesser production, though turning off a good many beans in the aggregate, are found in Maine, Wisconsin, Ohio, Pennsylvania, Iowa, etc, and as far south as Florida. California is a highly important producer of navy beans, but even in that great state the crop is grown commercially in a comparatively small area, notably Ventura, Santa Barbara, Sacramento and San Luis Obispo counties, with liberal quantities also produced in other California

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FIG. 29— COMMON WAY OF THRASHING BEANS

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counties. While the lima is the favorite in that state, all varieties of beans are successfully produced. After lima comes the Bayo, followed by the large whites and small whites in order. In a recent season the shipments of beans from California by sea, and rail were 110,000,000 pounds, or approximately 1,800,000 bushels.

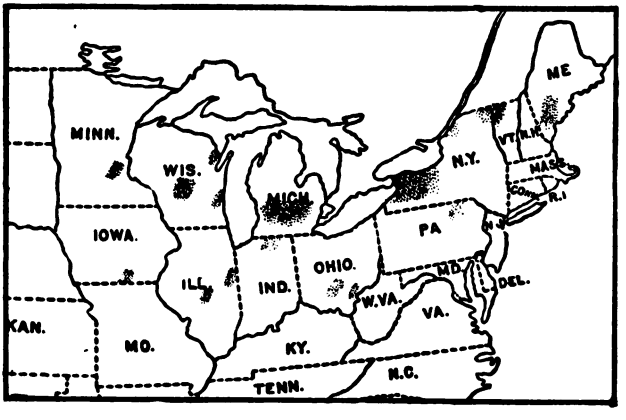

FIG. 30—STATES PRODUCING FIELD BEANS MOST LARGELY.

The heavily shaded portions indicate chief producing sections. California, also a large grower, is not shown.

This Pacific coast crop is not indicated on the little chart printed herewith, which shows the general distribution of the crop of small beans such as pea, navy and medium. As indicated by the heavily shaded portions, Michigan and New York are by far the chief producers. Michigan turns off in a good

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year 2,500,000 to 3,000,000 bushels beans and upward. New York 1,500,000 bushels and better, California 1,000,000 to 1,800,000 bushels. Other states are scattering, but in the aggregate produce a good many beans. The area given over to field beans on the occasion of the federal census of 1900 was 453,867 acres, and the yield returned at 11.2 bushels to the acre, having an average farm value at that time of $1.51 a bushel, or an equivalent of $16.82 to the cultivated area.

Up to 20 years ago New York led in the production of beans, the state yielding 42 per cent of the entire production of the United States in 1879. But ten years later its product was only 35 per cent of the total crop. Meanwhile Michigan has forged to the front, and now produces fully a third of all the beans grown in the United States, with New York turning off about 27 per cent. In Michigan the producing area is located chiefly in the four southern tiers of counties.

Figures taken from the United States census of 1900, covering the crop of the previous year, show that in a great many bean producing counties, the rate of yield is scarcely 10 bushels to the acre, while what may be considered a reasonable yield is 14 to 20 bushels, and big yields run 30 to 35 bushels. Phenomenal yields under particularly favorable conditions occasionally run higher, but are no criterion of what the average farmer, particularly east of the Rocky mountains, may expect. The federal census returns of an average of $16.82 an acre for the bean crop shows reasonably well when placed beside some other special crops. There is more

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expense attending harvesting and marketing, however, than is the case with certain other crops which may go direct from the thrashing machine to the distributing or consuming market.

Preparing beans for market.—The crop is by no means ready for distributing and consuming markets as it leaves the thrashing machine. Whether stored for a time to await a more favorable market, or promptly sold in the fall, the beans require intelligent care in handling. Judgment must be used to prevent the beans from molding, provided the climatic conditions are favorable to the undesirable state of things, and there is necessary work in assorting, removing foreign substances, throwing out discolored and damaged beans. Machinery is employed to a large extent, supplemented by hand labor in picking over the beans. As a result, most of the offerings on the wholesale markets are known as hand picked beans. Years ago this class sold at a premium, but now seconds and otherwise less desirable beans are utilized in some other way.

The various steps in the disposition of a crop of beans include thrashing and harvesting, cleaning, assorting, shipping to large distributing markets, whence they go into usual consumptive channels. The first requisite to be observed by the grower is to see that the beans are dry enough when drawn to the barn or the stack so as not to mold before thrashing. Many successful growers leave them to cure in the pods until the bean will not easily dent with the thumb nail, this being regarded as proof that they will keep indefinitely in a good dry bin.

Ordinarily, growers dispose of their crops just as the beans come from the machine, leaving the as-

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sorting and cleaning to others. It is generally considered that when beans are ready to thrash they are also ready for market. There is no set rule as to the time farmers dispose of their crops. If 90 per cent of the crop was sold in early fall it would be wise for the keen 10 per cent of growers to hold their beans until the early glut is out of the way, but there is no uniformity, and much depends upon the market and price movement.

Beans in good condition may be stored indefinitely provided care is taken against animal and insect pests and mouldings. Of course this by no means insures a better market a month later or a year later. Experienced growers realize that in storing beans for later market they must encounter possible difficulties with regard to mold, discoloration, etc, provided weather conditions are not wholly favorable at and soon after harvest. Thrashing is generally completed by January 1, immediately succeeding the harvest, although possibly the beans may not be sold before June.

While many growers sell their beans immediately after thrashing, many others store them for a time in granaries, the condition of the market in the fall largely determining the time of disposition. If prices are regarded by the farmer below an average, they are disposed to hold them for a time. One year with another probably 60 per cent of the crop, particularly in Michigan, is moved before January 1 each year. In this respect there has been a considerable change in the method of handling beans in the past few years. Formerly much unpicked stock was shipped from country elevators, located in what is properly known as the bean belt, and these beans

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eventually screened and put in shape for market at terminal points such as Chicago, Cleveland, New York, etc. But the increased area under beans has changed this, so that now there are large numbers of plants located in the bean sections fully equipped with machinery for cleaning, picking, polishing and bagging beans for market.

Dealers and distributers.—From the time the beans leave the growers they are in almost all instances handled by dealers of one class or another. In comparatively recent years there have been considerable changes in the methods of handling beans. An extensive system of cleaning houses and elevators has been established in bean growing sections for such great states as New York and Michigan. In the state last named there are over 200 elevators equipped with the best machinery for handling beans as they come from the farms, and making them ready for the markets. Thus it is not necessary for the farmer to own any special machinery for cleaning the beans. Large numbers of these warehouses are also found in the central and western counties of New York. One large concern with headquarters in Rochester, and with distributing offices in New York city, operates 20 of these houses in the growing districts in New York and Michigan. Many farmers draw the beans direct to these warehouses or elevators, others store for a time on the farm in bins or bags in dry granaries.

The process of cleaning is comparatively simple, yet interesting. Delivered at the elevator, the beans are first run through a cleaner which is equipped with large rubber rolls. These serve loosely to crush the lumps of clay and through the ingenuity

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of the contrivance a very large proportion of the earth, stones, bits of straw, etc, is removed. They are then run through a picker, a machine equipped with a large number of small rubber rolls, these serving to pick out the damaged and split beans and fine dirt in a lower screen, and rocks and large lumps of clay or dirt in upper screens.

Hand picked beans.—The beans are then ready for the picking rooms. In the Michigan warehouse large numbers of girls and women are employed; in New York these and also men and boys to some extent. The work done by their nimble fingers is in removing discolored beans, or anything else undesirable, that has escaped the previous cleaner. This hand picking of beans is done almost entirely in the elevators or bin handlers after they have been purchased from the growers. The proportion of beans hand picked on the farm where grown is now so small that it can scarcely be estimated. In the hand-picking process a mechanical device is in use in the form of a movable canvas apron or belt passing slowly in front of the pickers. Spread thinly on this surface the hand picker has ample opportunity to detect each imperfect bean or bit of foreign matter and to remove it. Meanwhile, the thoroughly cleaned and practically perfect beans move along on the apron and are discharged into spouts or elevators, carrying them to the point where they are sacked.

Sometimes the beans are run through polishing machines which remove the particles of dust and brighten the stock, making it as nearly perfect as possible. It has been found that by a vigorous

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polishing, sometimes making use of a slight percentage of lime with the other ingredients used, beans will not grow moldy, nor in any way seriously discolor, provided proper storage is observed.

The fully cleaned beans are placed in bags, usually holding 160 pounds, sometimes 165 to 168 pounds, and are then ready for market. There is little or no loss to the holder on account of storing beans provided the stock is perfectly cured when thrashed. But if this is not the case the beans may sour and become unsalable. In a good many instances beans are stored in farmers' granaries for several years at a stretch without particular difference in appearance, although such beans will not cook as well.

Beans are bought from the farmers on a hand picked basis in both New York and Michigan. The grower brings the samples to the buyer who tests them and states whether they will lose 1, 3 or 5 pounds on account of damaged or discolored beans; a certain measure is taken, perhaps a quart, and the poor beans removed. These are carefully weighed on a delicate balance, so that it is possible to compute the number of pounds of poor beans in a bushel, as delivered by the farmer, a quart being regarded as a fair sample. This estimated number of pounds of poor beans in a bushel is charged against the seller at 5 cents a pound. For example, if it is determined that 3 pounds of poor beans are to be picked out of a bushel, and the beans are sold at an agreed price of $1.40 a bushel, they will net the farmer $1.25. If the price is $1.25 for choice hand picked, and they lose 3 pounds, the farmer would receive $1.10 for the bushel.

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The generally agreed weight on which sales are made is 60 pounds to the bushel. The farmer sells the beans direct to the dealer at the interior shipping point. Very few beans are consigned direct by growers to commission merchants in the large cities. The dealer who buys, cleans and subsequently handles the beans may be an independent operator or may represent some syndicate with a large number of these cleaning and storage houses. After the beans are delivered and properly screened and cleaned the farmer takes the screenings home for stock feed. Beans which have been stored under unfortunate conditions, and are perhaps discolored, or have become musty are practically spoiled for edible purposes, go to stock feed for sheep and swine. In Michigan most of the picking culls go to farmers for feed, the latter paying $12 to $16 a ton. The best culls, however, are often sold to the canning factories for canned beans, realizing a price of 50 to 60 cents a bushel, or perhaps less than half the value of hand picked beans.

The dealers and operators of these country warehouses eventually sell the beans, perhaps through city brokers, to wholesale dealers in the large distributing centers. The beans are handled in carlots, 60 pounds to the bushel, including the bag as net. A carload consists of 250 bags or more.

Provided the beans have been properly cured in the fall and stored in a dry, cool place, they will keep without difficulty. But it has been often determined that if damp when thrashed, it is very difficult, if not impossible, to dry them thoroughly, except by kiln drying. Consumers, and to some extent growers, fail to distinguish the fact fully that there is a

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wide difference in the quality of beans, even granted that they are properly grown and cured. Between a very poor bean, which may be fair to look upon and the choice product of Michigan, California, New York or other states, there is considerable difference in value as a food product.

The growing of lima beans is a specialty in California. In a good average year, and on good land, the rate of yield is 1500 to 1600 pounds cured lima beans to the acre. Occasional yields are double that, but in such cases under unusual conditions when the land has been especially well irrigated, or possesses unusually favorable environment or productivity. In shelling lima beans a thrashing machine is used, somewhat similar to that in handling grain or in shelling pea beans further east. After thrashing, the beans are removed to warehouses and passed through a cleaner equipped with screens for removing foreign substances such as pods, bits of sticks gravel, etc. They are then sacked and are considered in good condition, justifying the name of recleaned lima beans. Ordinarily no hand picking is necessary. Nearly every year the beans are harvested without rain falling on them, but when occasionally caught by showers and damaged in the fields, they are then hand picked to remove the stained beans from the good ones. In marketing lima beans each grower acts independently, selling to the best bidder. Attempts have been made to market this crop through the various co-operative agencies, but so far without much success. Some seasons a farmer will hold his crop if he considers the price too low. What may be considered a normal price to the farmer one year with another is 2½ to 3 cents

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per pound, and at this level the crop is regarded a profitable one. In some seasons growers secure 3½ cents at the shipping station. The lima bean crop is very largely contracted by growers to dealers before the harvest is completed. After the beans are in the warehouse owned by large dealers, they are generally stored for a time, and withdrawn for shipment on eastern orders as occasion warrants. The storage facilities on the Pacific coast are exceptionally good, and expenses lighter than in storing the beans further east. Stored near points of production they can be more economically routed and shipped into distributive channels than would be the case were they stored in eastern centers, and reshipped. For this reason the principal stocks of lima beans are usually found on the Pacific coast. In a good year the crop of California lima beans is 800,000 bags, weighing 80 pounds to the bag.

Varieties for leading markets.—The standard varieties of beans for market are few. The pea bean is far and away the most popular east or west. In the great wholesale market of New York city, probably 60 per cent of all the beans handled are pea beans. Next in popularity in the market named is the red kidney, but of course other sorts are much in vogue. Lima beans are in considerable favor in all sections. While all white beans are sold on a 60 pound basis in New York city, red beans are 58 pounds to a bushel. Sharing the pea bean in popularity is the medium, a white bean but little larger and longer, this also very much used in Boston. The medium bean is considered by many growers the best producer to the acre, and the dealers regard it well because it ripens a little earlier, more evenly, and is

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less likely to damage from the weather. In Michigan, the pea bean is the leader, and this bean is also often known as the navy bean. The southern and western trade call almost entirely for this bean, and so far as that is concerned, enormous quantities are also used in the middle and eastern states. In New York and New England, in addition to pea and medium bean, marrow and kidney beans are largely used, while they have comparatively little sale in the West. For that matter, western growers do not favor them, claiming they ripen unevenly and soon run out. For the Boston market pea beans, yellow eyes and red kidneys are the most popular varieties in the order named. Michigan largely controls the trade in pea beans, not only for Chicago and other western markets, but also in the East. Yet in normal years a good crop of pea beans is produced in central and western New York.

Consumption and prices.—Most of the beans grown in the United States are consumed at home. There is a moderate foreign trade, but the quantity shipped out one year with another is more than balanced by the imports of foreign grown beans. As shown in one of the accompanying tables, where official figures are presented covering a long series of years, we buy more beans abroad than we sell. In other words, production has not yet overtaken consumption, and there should be a reasonable profit in growing beans for market even under considerable extension of the area given over to this crop.

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FOREIGN TRADE IN BEANS

Years	Exports Bushels	Exports Av val	Imports Bushels	Imports Av val
1905-6.....	447,474	$2.14	458,041	$1.45
1904-5.....	330,321	2.21	472,572	1.32
1903-4.....	248,805	2.19	978,187	1.24
1902-3.....	232,841	2.28	,088,465	1.20
1901-2.....	324,481	1.96	881,966	1.30
1900-1.....	468,670	1.84	1,099,640	1.18
1899-0.....	617,355	1.59	967,031	1.08
1898-9.....	883,201	1.43	184,499	89
1897-8.....	854,284	1.28	163,560	.91
1896-7.....	900,219	1.23	482,986	1.01
1895-6.....	473,975	1.33	613,801	1.07
1894-5.....	242,680	1.76	1,535,960	1.00
1893-4.....	326,748	1.74	1,184,081	.94
1892-3.....	389,913	1.91	1,754,943	.99
1891-2.....	637,972	1.39	874,050	1.09
1890-1.....	251,063	1.88	1,656,768	1.25
1889-0.....	261,212	2.13	1,250,287	1.04

Domestic grown beans exported to foreign countries go chiefly to Cuba, Porto Rico, etc. This business is not growing very rapidly. In fact, the development of the West Indies in some ways seems to have retarded our export trade in beans. As Cuba and the other islands gain in population of whites with American ideas, they show more disposition one year with another to use increased quantities of canned fruits and vegetables from the United States rather than such food products as dry beans. Exports of beans direct to Europe are small. Farmers there grow about all the varieties we have here,

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and usually grow enough for their own consumption with a surplus for export. Some of these reach the United States each season.

Havana is a great market for marrow beans, while red kidneys go largely to other ports in Cuba, and also to Porto Rico. The table showing the foreign trade in beans emphasizes this fact of a small export movement from this country. The average value placed by the government on the beans exported is comparatively high, but the quantity shipped is not enough appreciably to affect prices paid to farmers. The figures of imports are, if anything, more significant. They show that up to a few years ago foreign beans to the extent of 1,000,000 bushels to 1,500,000 bushels came into this country annually, or 15 to 25 per cent of a normal full domestic crop. There would seem to be opportunity for considerable extension of the bean area to make up the deficiency now made by foreign grown beans in consumptive requirements. Foreign beans pay a duty of 45 cents a bushel. There has been no change in the tariff for a number of years.

In the small table showing the annual production of beans in the five leading states, it is significant that the crop has gained but slowly in volume. The figures show the number of bushels in round millions and tenths of millions for each decennial census running back to 1870. While the data are no doubt subject to some modification, it is reasonable to believe that the crop has not greatly increased since 1900, although the tendency is in that direction. In another table figures are given showing the area in states cultivating 1,000 acres or more of beans. These are for the census year of 1900,

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covering the crop of 1899, and must be regarded as approximately accurate. Comparing these figures with those of the preceding decennial census covering the crop of 1889, it will be shown that the production of beans in Michigan increased three fold in the 10 years. In New York, the gain was about 20 per cent. California showed an apparent decrease but the 1899 crop was not a normal one in rate of yield, and therefore the figures are no criterion as to the large outturn of that great state. The difficulties of comparison one decennial period with another, are shown in some other states. For example: Maine indicates a slightly smaller yield, but this may have been due to temporary conditions rather than tendency to devote less land to this crop. The census figures are not very clear relative to the production of dry or field beans in the South. The data compiled and printed relate very largely to green beans, marketed in the spring in crates or baskets, although some attention is given to the crop treated in this book.

LEADING STATES PRODUCING BEANS

The figures are in round millions and tenths of millions of bushels, and are taken from the federal census returns.

	Bushels			
District	1900	1890	1880	1870
U. S.....	5.1	3.2	3.1	5.7
Mich.	1.8	0.4	0.2	0.3
N. Y.....	1.4	1.1	1.3	1.1
Cal.	0.7	0.7	0.4	0.4
Me.	0.1	0.1	0.2	0.3
Wis.	0.1	0.1	0.1	—

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STATES CULTIVATING 1000 ACRES OR MORE OF BEANS

States	Acres	Number of bushels produced	Value	Average bushels per acre	Average price per bushel	Production in 1899
Michigan	167,025	1,806,413	$2,361,020	10.8	$1.31	434,014
New York.....	129,298	1,360,445	2,472,668	10.5	1.82	1,111,510
California	45,861	658,515	1,022,586	14.4	1.55	713,480
Florida	9,189	176,304	139,349	19.2	0.79	6,613
Maine	10,252	137,290	290,885	13.4	2.12	149,710
Virginia	6,411	56,189	66,066	8.8	1.18	24,048
North Carolina..	5,381	49,518	50,703	9.2	1.02	36,909
Tennessee	5,563	48,736	57,660	8.8	1.18	29,780
Missouri	4,376	45,647	73,850	10.4	1.62	29,632
Minnesota	3,290	36,317	49,685	11.0	1.37	61,009
New Mexico....	3,349	36,022	73,001	10.8	2.03	7,843
Indiana	2,999	30,171	46,281	10.1	1.53	34,988
Illinois	3,451	30,122	46,084	8.7	1.53	21,308
New Hampshire	2,892	29,990	62,799	10.4	2.09	44,589
Colorado	2,634	28,570	49,169	10.8	1.72	7,265
Vermont	2,404	27,172	51,629	11.3	1.90	31,880
Iowa	2,427	24,903	38,296	10.3	1.54	33,769
Pennsylvania ..	2,182	23,957	38,719	11.0	1.62	11,356
Ohio	1,828	19,042	33,307	10.4	1.75	30,213
Alabama	1,756	17,865	15,507	10.1	0.87	4,841
Georgia	1,927	17,489	17,982	9.1	1.03	19,619
Arkansas	1,490	15,582	17,046	10.5	1.09	8,570
South Carolina..	1,657	14,925	13,936	9.0	0.93	8,018

NOTE.—These figures are from the United States census of 1900, and it should be distinctly understood that they do not wholly apply to dry or field beans. They refer in part to beans grown and marketed whole, and fresh, as string beans. The leading states for dry beans are Michigan, New York and California. The acreage has largely increased in recent years. In 1904 Michigan alone reported 350,895 acres and a yield of 5,050,000 bushels; in 1905 the rate of yield to the acre was larger than the preceding year.

The price of beans one year with another varies considerably. In such large distributing markets as Chicago, pea beans sold in the late 90's as low as 70 cents a bushel wholesale, and since that time have been well above $2. What may be regarded as a normal price range in the wholesale western markets is $1.50 and $2 a bushel; in New York and Boston the usual freight difference in the way of a premium. The weight in the wholesale markets,

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as in the producing districts is 60 pounds to the bushel. Medium beans ordinarily sell a little lower than pea beans, but not always. For other varieties there is no fixed ratio or difference, certain kinds grown in a comparatively small way for special trade even commanding figures which seem high when placed beside those ruling for such standard as pea beans. In some seasons pea beans, the most largely grown, seem to be in excessive supply, and this temporarily results in such other varieties as medium and marrow beans selling relatively high.

WHOLESALE PRICES FOR PEA BEANS

(Quotations apply to bushels in round lots)

Year	Chicago		New York	
	Nov 1	May 1	Nov 1	May 1
1906-7.....	$	$	$	$
1905-6.....	1.70	1.55	1.80	1.65
1904-5.....	1.75	1.75	1.85	1.80
1903-4.....	2.00	1.80	2.15	1.85
1902-3.....	2.30	2.10	2.45	2.25
1901-2.....	1.92	1.85	2.05	1.85
1900-1.....	1.87	1.90	2.05	2.10
1899-0.....	1.85	2.18	1.89	2.25
1898-9.....	1.15	1.20	1.27	1.32
1897-8.....	1.00	1.30	1.13	1.41
1896-7.....	.98	.72	1.25	.90
1895-6.....	1.25	.94	1.25	1.18
1894-5.....	1.52	1.75	1.85	2.05
1893-4.....	1.80	1.75	1.90	2.00
1892-3.....	2.00	2.05	2.10	1.95
1891-2.....	1.80	1.75	2.00	1.65
1890-1.....	2.25	2.30	2.40	2.35
1889-0.....	1.75	1.80	2.00	1.95

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CHAPTER XII

GARDEN BEANS

A book of this character would hardly be complete without a reference to beans for the garden. This brief chapter is designed to include the most important features presented by this crop and give in a concise yet helpful way the latest there is to offer from the scientific as well as practical side of garden bean culture. Generally speaking, garden bean culture does not differ radically from that already given in detail for field beans, though it is generally agreed that a richer soil should be given garden beans than to the field crop. Garden beans are usually fed higher than field beans, one reason for which is that the former crop has to be forced for not only productiveness but for earliness as well. Garden beans are very tender; they succeed best in a rich, light, well drained, and somewhat sandy soil. If a southern exposure can be provided, so much the better.

Garden beans classified.—There are various ways of dividing the different varieties of garden beans. Professor Waugh* says common beans are of two general types, bush and pole. Professor Irish** of Missouri classifies them according to their use, as string or snap in reference to the young or green pods; shell beans when the seed is used in the green state, but large enough to shell; and the ripe seed.

*The Home Garden, p 28. **Garden Beans, p 83.

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Again there are green podded sorts. While all pods are more or less green at first, those known as wax podded sorts change to a yellowish color when of edible size. The wax podded are as a rule less stringy than the green podded, but are also less hardy and somewhat more subject to diseases. Therefore, in selecting for the garden, both types had best be chosen. The stringiness in snap beans is, of course, to be avoided and in this connection Leonard Barron gives a test which will determine whether a bean is stringy or not as indicated by the tips. He says* one can even tell whether beans are good or not by merely looking at the point that projects beyond the body of the bean. If it is limp or curved the bean will snap; if it is straight and rigid there will be a string. (Fig. 31.)

String or snap beans should not be planted until all danger of frost is past. Then drill in rows 2 to 3 feet apart and finally thin to 4 to 6 inches between plants. A strong argument for growing string beans is they can be obtained early and, therefore, everything possible should be done to encourage rapid growth. In addition to giving congenial soil and exposure as indicated above, earliness can be encouraged by readily soluble fertilizers. Cover the seed with 1 to 2 inches of soil, depending upon the amount of moisture present. Give liberal culti vation, though shallow, leave the ground mellow and well pulverized. Bush beans have a strong disposition to ripen their entire crop at the same time. While this characteristic is desirable for the commercial field bean grower, it is not to be encouraged in the case of string beans. If the green pods

*Country Life in America for March, 1906.

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are picked off promptly as they reach the edible size the season will be considerably prolonged, in some cases two or three weeks. Successive crops may be planted every two weeks of different varieties to aid one in supplying the table with delicious string beans throughout the summer.

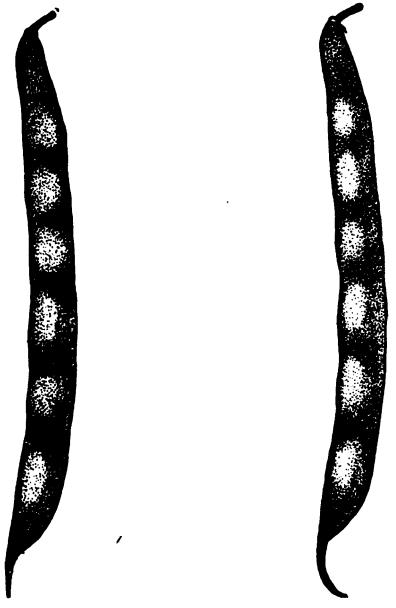

FIG. 31—"STRING" BEANS.

Varieties of snap beans.—There are many varieties of snap beans on the market; all have their merits. The grower should remember, however, that as in commercial bean growing, different varieties have their favorite locality, so each grower

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should experiment for himself as to the best variety. The different Valentine varieties usually do well for snap beans. The plants are medium to large, pods round, green, tender; seeds medium to large, blotched and speckled with various shades of red and brown. Early Mohawk and Long Yellow Six Weeks are also given as good snap varieties by O. M. Morris*. Early Mohawk is a medium to large kidney shaped bean, brown speckled and blotched with dark red. Long Yellow Six Weeks is similar to Early Mohawk only it is solid brown. Morris names among the best wax or yellow podded varieties: Golden Wax, Dwarf Black Wax and Refugee Wax. Golden Wax is a small bean, white, covered with blotches of red. Dwarf Black Wax is a medium sized black bean. Refugee Wax is a small brown bean covered with blotches of black. Professor Irish says** that among the best green podded sorts for snaps are Valentine, Refugee, Sion House, White Flagolet, Cream Stringless, Canadian Wonder and Mohawk. For the wax sorts he names Black Wax, Golden Wax, Davis, Currie, Yosemite, Wardwell and Detroit. Bailey*** says the German Black Wax is the type of most of the yellow podded varieties and the progenitor of many, but the newer and more carefully selected sorts are likely to prove best in most situations. Of these Golden Wax, Flagolet Wax, Yosemite, Mammoth Wax, Valentine Wax and Refugee Wax are best known. Green podded varieties for snaps are not so popular but sell readily in many markets. Of these Early Red Valentine, Extra Early Refugee and Long Yellow

*Okla Bul 56. **Garden Beans, p 83. ***Market Garden, p 363.

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Six Weeks are very good. Further data on varieties will be found in an earlier chapter of this book, headed Varieties and Where They Succeed.

Pole beans.—All garden beans will stand heavy fertilizing but pole sorts respond especially well to liberal fertilizers. Pole beans require a longer season than bush varieties. The poles are sometimes set 4 feet apart each way before the beans are planted. Many growers set large posts at either end of the row, then string wire; small stakes are attached in the intervening distances. Still another method is to set the end posts as before and stretch two wires tightly, one 6 inches to 1 foot from the ground, and another 4 feet from the ground. Small wires are run between these two. The beans climb on the small cross wires. Four to five seeds are planted around each pole at a depth of 1 to 1½ inches. Horticultural Pole beans or Speckled Cranberry and Golden Cluster are popular varieties of pole beans among the kidney bean class. Professor Rane* has been very successful in growing early beans under glass. He finds the time from germination to maturity under glass ranges from 54 to 62 days. Pole limas will be considered under the following head.

Lima beans are even more tender than other beans. It is, therefore, very important that the ground be warm before they are planted, otherwise, they may rot or get a weak start at best. The early limas are usually planted in hills of four or five seeds each, 3 to 4 feet apart each way. Stakes are provided as already mentioned. Dwarfs are set closer. Jordan** reports that after trying out various ferti-

*N H Bul 99. **N J Rpt 1898, pp 77-180.

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FIG. 32—PRODUCTIVE LIMA BEANS.

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lizers for limas, that nitrate of soda hastened maturity and that dried blood gave the best yield Hansen and Thornber* say, "It is sometimes recommended to plant lima beans with the eye down. Some of Burpee's and Henderson's were tested this way but no difference was observable from those planted in the ordinary manner." C. S. Kempton, a successful Massachusetts gardener, never fails to get a good crop of lima beans. His method in getting the beans started is as follows: Shallow boxes such as tomato plants are often started in, are secured and half filled with earth and the beans, eye downward, and not more than ½ inch apart, are pressed into the earth just enough to keep them in an upright position. In a box 15x18 inches, about 400 to 500 beans can be planted. He then fills the boxes nearly full of earth, covering the beans about 1½ inches deep and saturates the soil with water. In a week or ten days, if the boxes have been kept in a warm place and occasionally watered, the seed will have all sprouted and taken root. Then the boxes are taken to the field or garden and the beans transplanted, placing four or five plants to a hill and thinning eventually to three. Mr. Kempton says, "Following this method no one will ever fail in growing lima beans by reason of the seeds failing to sprout or rotting."

In comparison of early and dwarf limas Jordan,** after carefully experimenting, did not note much difference in earliness of maturing. But in amount of early fruit and total yields the early sorts were considerablv ahead. Standard varieties of early limas

*S Dak Bul 68, pp 105-158. **N J Bul 191, pp 216-268.

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are Dreer's Improved Early Jersey, Ford's Mammoth, King of the Garden, and the Sievas. Of the two types of dwarf limas, Burpee's Bush lima is the most popular large sort used for shelled and green purposes and Henderson's Dwarf lima for the small lima used green or dry. Sievas are valuable chiefly because of their earliness. Santa Barbara and Ventura counties, Cal., produce the largest quantities of lima beans of any similar area in the world. As high as 2,000 carloads have been grown there in one season. Further reference to varieties are featured in the earlier chapter on varieties. Insect and fungous pests are considered in the chapter given over to that subject. For history, evolution, relationship and detailed cultural principles, see Bulletins 115 and 87, Cornell University experiment station, also Iowa Bulletin 10 and New Jersey Report for 1897.

Bean trucking in south.—The snap bean is one of the leading crops of the southern truckers. It needs light, dry land and warm exposure. It can be cheaply grown because it occupies the ground but a short time, and also makes a good succession crop to early cabbage without additional fertilization. When the crop is gathered the vines are often plowed under to fertilize the land. Battle* says since the early beans are the most profitable, many growers begin planting as early as March 15 though there is a serious risk that such early ones will be killed by frost. The green beans are shipped in well ventilated bushel crates and the pickers are instructed to pick the pods as soon as they are of fair size and before they are old enough to show the

*N C Bul 112, pp 49-51.

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bulge of the seed. Packing in crates is done very carefully as beans shrink in transit and crates should be full on arrival (Fig. 28). For the earliest planting, Mohawk has led for many years, largely owing to its hardiness, however; it is soon superseded by beans of better quality. Extra Early Valentines are recommended for the green podded sorts; Golden Eye Wax bean for the yellow podded sorts is recommended by Professor Battle.

Mulching.—Professor Emerson* reports experiments on the use of straw or other similar material as a mulch for garden vegetables. Out of 40 growers who tried a mulch, 22 report more favorable results than with cultivation; 15 favored cultivation and three noted no particular difference. It was thought that if the growers had cultivated until the ground was warm and then mulched the results would have been more marked in favor of the practice. Emerson** gives conclusions on mulching experiments with Navy and Golden Wax beans. He found that mulching was decidedly beneficial. Lima beans showed but little difference as regards the two methods of culture. The conclusion was that in normal seasons mulching increases the yield over cultivation except in cases of late planting or naturally late varieties, when by delaying the maturity the beans are more likely to be injured by early fall frosts. Professor W. T. Macoun*** in experiments in growing beans under cheesecloth found that beans were ready for use earlier inside than outside and were nearly as productive. The experiments were conducted on the Central Experimental farm in Canada.

*20th Century Farmer, 1902. **Neb Bul 80, p 26. ***Gardening, 1904, p 517.

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Canning beans has grown to a most important industry. When the writer visited large bean growing sections in New York recently, factory after factory was found running night and day putting up the beans grown by the farmers. Professor W. B. Alwood* says the most satisfactory quality of

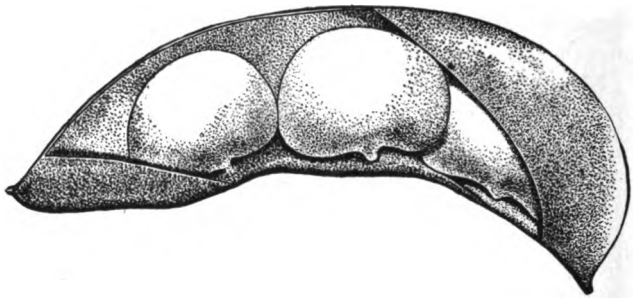

FIG. 33—AROOSTOOK BUSH LIMA BEANS

snap beans used for canning has been the Mammoth, Stringless Valentine and Mammoth Stringless Green Pod. Cooking the stock 45 minutes at boiling temperature in an open kettle gives uniformly satisfactory results. It is suggested that a little finer grade stock might be secured by cooking ten minutes in a retort at 216° and then running the temperature up to 220° just at close of cooking.

Beans can be cooked and served in a great variety of ways. String beans are commonly served in thickened milk after having been boiled in water and seasoned with pepper and salt. Professor Irish says** that they are often pickled along with cauliflower, cucumbers, and other vegetables or preserved

*Va Bul 146, pp 23-47. **Garden Beans, p 84.

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in brine and when wanted are soaked in water some time before cooking. Shell beans are treated in a similar manner. The ripe seed is boiled and packed after having been soaked in water for an hour or more, the exact method varying with different tastes. In Mexico, where frigolis form a part of almost every meal, they are usually prepared by first boiling until tender and then frying in lard, usually until reduced wholly or in large part to a paste which is commonly of a chocolate color, sometimes shaded with violet owing to the color of the seeds thus employed. Prof J. F. Du Pre* says that he put up for winter use several barrels of beans in brine, and a number in salt. In both cases the beans kept well, though those packed in dry salt were the better. The following spring they were sound and sweet as the day they were put up. A little soaking in water to extract the excess of salt and one has the bean almost as good as when freshly gathered.

*S C Bul 10.

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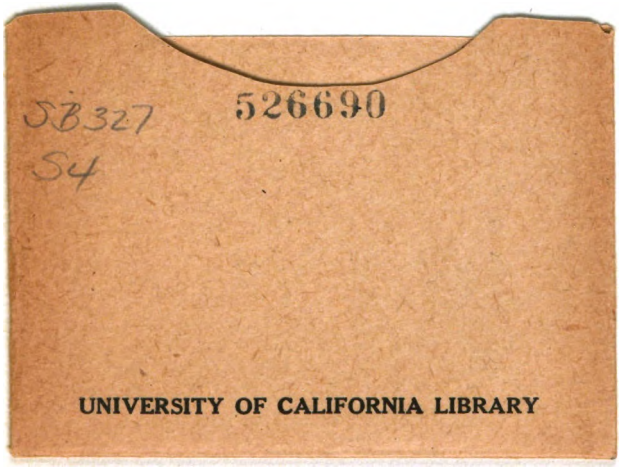

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